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A PERSPECTIVE ON FLOOD PROTECTION OF AGRICULTURAL LANDS.(U)

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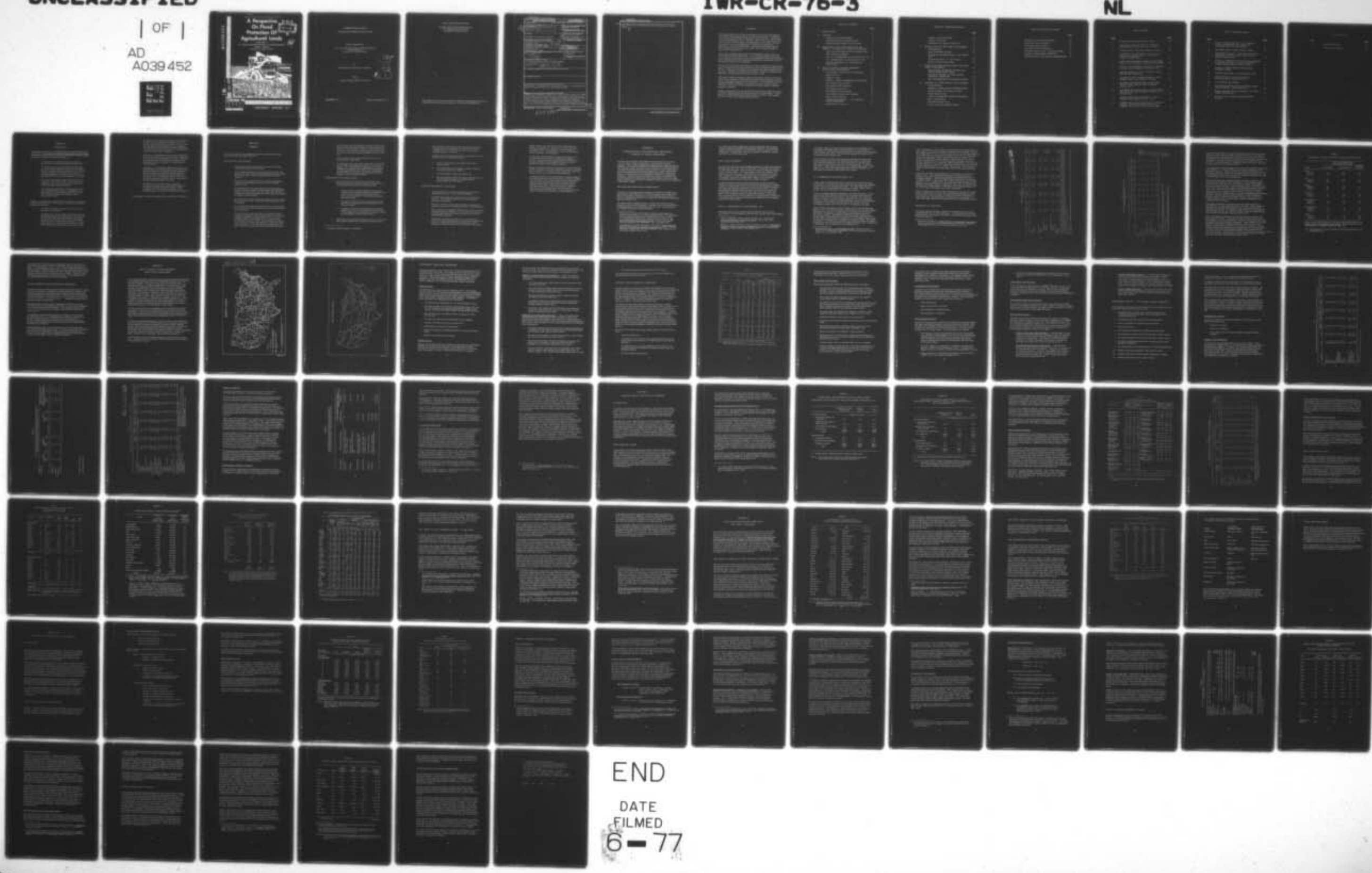

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A Perspective On Flood Protection Of Agricultural Lands

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Submitted to:
U.S. ARMY ENGINEER INSTITUTE for WATER RESOURCES
Kingman Building
Fort Belvoir, Virginia 22060

DECEMBER 1976

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CONTRACT REPORT 76-3

A PERSPECTIVE ON FLOOD PROTECTION OF AGRICULTURAL LANDS

A Report Submitted to:

U.S. Army Engineer Institute for Water Resources
Kingman Building
Fort Belvoir, Virginia 22060

by

Development and Resources Corporation

Under

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This report summarizes conclusions of the major studies of world food demand and products, surveys program level data on the status of rural lands in the Corps of Engineers flood control programs and investigates data and methodology employed to evaluate the effect of drainage and flood control measures.

Key findings are that increased pressure can be expected for food and feed grains in export markets and that alluvial soils are highly competitive producers. Total areas of irrigated and reclaimed agricultural wetlands will increase, → next page

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with almost 50% of the wetland conversions projected to occur in the South Atlantic Gulf, Lower Mississippi and the Tennessee Water Resource Regions.

FORWARD

This report reflects an attempt to develop an overview of the situation confronting flood control programs for agricultural lands. Traditional policies have reflected the overproduction state of the U.S. agricultural economy following the 1930's. However, since 1970 a reversal in policy and in the basic demand supply relationships have occurred. Food and feed exports are now a substantial cornerstone of foreign policy. In response to increased foreign sales, crop prices have leaped upward and cropping constraints have been lifted. What should this mean to agricultural flood control?

This report evaluates and surveys the conclusions of major studies of world food demand and production. It also surveys program level data on the state of rural lands in the Corps of Engineers flood control program and investigates data and methodology employed to evaluate the effects of drainage and flood control measures.

The report finds that increased pressure can be expected for food and feed grains in export markets and that alluvial soils are highly competitive producers. Total area of irrigated and reclaimed agricultural wetlands will increase. Wetland conversions may, however, conflict with national wetland policy as expressed in Section 404 of PL 92-500.

Additional studies are needed to obtain the necessary data on soil productivity and its response to flood reduction measures and drainage improvement for potential major flood control projects. The implication of future demand and supply conditions on crop prices is that increases can be expected. Thus, price level assumptions utilized in project evaluation should be evaluated.

Finally, program priority for agricultural flood control needs examination. If balance of payment and foreign policy factors are significant, a higher priority for agricultural flood control might be in order. The paradox may be in conflict with national wetlands policy.

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CHAPTER I

INTRODUCTION

Development and Resources Corporation (D&R) is pleased to submit this report, titled A Perspective on Flood Protection of Agricultural Lands, in fulfillment of Purchase Order DAWC 31-76-M-0310. Contract requirements were reflected in four tasks as follows:

-- To summarize conclusions of the major studies of the projections of world food demand and production.

-- To evaluate the Interregional Model being developed for the U.S. Water Resources Council for the National Water Assessment (NWA) by Professor Earl O. Heady and his colleagues at Iowa State University for its potential application in indicating the use of rural lands protected by U.S. Army Corps of Engineers projects.

-- To survey Corps' program data from various sources in the Office of the Chief of the U.S. Army Corps of Engineers on the status of rural lands in Corps flood control and major drainage programs.

-- To investigate available data to ascertain the present state of knowledge of the effects of drainage and overbank flooding on the agricultural productivity of flood plain soils and to appraise the methods used to evaluate these effects.

In order to accomplish these tasks, D&R has defined and completed the following study objectives. These objectives conform to the chapters presented in the report.

-- In Chapter II, summary statements of the key items of this report are presented.

-- In Chapter III, five major studies projecting world food demand and production are summarized. These studies include projections made by the Food and Agriculture Organization (FAO) of the United Nations, Iowa State University (ISU), the University of California, and two studies made by the Economic Research Service (ERS) of the United States Department of Agriculture (USDA).

-- In Chapter IV, the interregional model being developed for the U. S. Water Resources Council for the 1975 National Water Assessment by Professor Earl O. Heady and individuals at Iowa State University is evaluated. The evaluation included the NWA's potential application in indicating the use of rural lands protected by projects of the U. S. Army Corps of Engineers.

-- In Chapter V, program data from various sources in the Office of the Chief of the U. S. Army Corps of Engineers on the status of rural lands affected by flood control and drainage programs of the Corps are surveyed. This information was also evaluated for its applicability to Corps programs.

-- In Chapter VI, comprehensive framework surveys, the National Inventory of Soil and Water Conservation Needs, the draft report of the Flooding Technical Committee of the Water Resources Council, and the flood insurance studies of the Federal Insurance Administration are surveyed. This investigation presents a cross section of flood plain data now available, with an examination of both the format and content of the data.

-- In Chapter VII, the present Corps of Engineers methodology on flood control and drainage impacts on agricultural productivity is examined as it relates to flood plain soils. The various components of the methodology used to evaluate these impacts are appraised.

The findings of Chapters III through VII are summarized in Chapter II.

CHAPTER II

SUMMARY

The critical issues and key findings as they affect new flood control and drainage facilities are summarized here.

AGRICULTURAL PROJECTIONS

-- The demand for major land-using U.S. crops will increase substantially within the next 25 years.

-- A net worldwide shortage of cereal grains will develop, with surpluses for export available from North America and Oceania. The preponderance of these surpluses will be from North America.

-- The export market demand, however, could be substantially limited by the willingness and capacity of the developing countries to pay.

-- All projections for U.S. production of cereal grains indicate that the U.S. share of total world production will remain within a range of 19 to 28 percent to the year 2000. This indicates a substantial increase in production as world production increases in response to world demand.

-- The 1975 National Water Assessment (NWA) projections indicate that present U.S. trends of decreasing total agricultural lands will continue.

-- The 1975 NWA also indicates that total areas of irrigated lands and reclaimed agricultural wetlands will increase in most water resource regions.

-- The projections for conversion rates of irrigated lands and wetlands to agricultural use and the projections for conversion of marginal croplands to nonagricultural uses are based on established trends. Accordingly, due to the quality of the remaining land resources, which could reasonably be expected to be declining, the rates could experience a significant change at any future time. Trade-offs between marginal lands presently cropped and marginal wetlands need further assessment.

-- Almost 50 percent of the wetland conversions are projected to occur in the South Atlantic Gulf, Lower Mississippi, and Tennessee[1] Water Resources Regions. Most of the remaining areas of conversion are nearly equally divided between the North Central and Northeast geographical sectors of the U.S.

-- The foregoing are only general indicators of areas for potential future Corps works.

-- An important factor in the rate of conversion is Section 404 of PL 92-500. Section 404 gives the U.S. Army Corps of Engineers the responsibility of regulating the discharge of dredged or fill material in the waters of the United States. It is anticipated that because of this policy a substantial portion of the new cropland acreage projected by the NWA will have a restriction on conversion.

SIGNIFICANCE OF AVAILABLE DATA

-- The major data source in the Office of the Chief is the Planned Programming Budgeting System Computer Record which contains information on the following areas:

1. Potential flood protection capability of Corps flood control projects, including authorized and unauthorized projects for both urban and rural lands and the size of the area protected. These data are presented by Corps districts.

2. The extent of rural flood protection provided for both authorized and unauthorized Corps projects by water resource regions.

3. A summary of projects by Corps district, showing the number of projects, the percent allocation of benefits to rural lands, the total drainage area and size, and the type and quantity of flood control features.

-- These tables are important in that they summarize rural lands that fall within authorized and unauthorized Corps projects.

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[1] *Not under Corps of Engineers jurisdiction.*

-- The information does not indicate the amount of agricultural cropland that received benefits, nor does it indicate those presently nonagricultural lands that could be converted to cropland because of the project.

-- Additional sources with some potential for assistance in Corps planning include the following documents:

1. the U.S. Department of Agriculture Conservation Need Inventory,

2. the Draft Report of the Flooding Technical Committee of the Water Resources Council,

3. the comprehensive framework studies, and

4. the flood insurance studies now under preparation by the Federal Insurance Agency of the Department of Housing and Urban Development.

DRAINAGE AND BENEFIT EVALUATIONS

-- Corps methodology for damage and benefit assessments are standardized to a degree by Corps-wide guidelines.

-- Variations exist within these guidelines among the different districts. Each district tends to use its own established procedures consistently.

-- There are allowances and procedures within the guidelines to adequately assess most crop and production-associated damages.

-- The present general standards and district procedures are good in that they allow for flexibility in accounting for the adequacy of available data and expected regional variations in the type of actual damages incurred.

-- The present assessment methods may or may not accommodate the critical timing aspects of the agricultural production process, including vulnerable plant growth stages and the scheduling of cultural activities. The historical events used to

qualify damages may reflect the critical timing aspects of damages or they may not. Similarly, the chances that future flood damages may occur during a critical period may be difficult to assess. The desirability of more refined analysis in this area needs to be determined.

-- It would appear that additional consideration should be given to income losses due to the loss of subsequent cropping choices. Timing, deposition of herbicides, and introduction of pests and disease have potential long-term effects that should be considered in the damage evaluation.

-- Because of regional variations in damages and in the availability of data, refinement of the general guidelines should be restricted to the district level. Freedom to fully consider the actual local damage characteristics needs should be maintained.

-- A separate potential area for improvement of benefit evaluation lies with the minimum criteria for sizing of protection facilities. For rural lands, a lower return frequency for design storms could be used, bank freeboard could be reduced, and other minimum design factors could be reduced within prudent and conservative limits. This action would be reflected in a decrease in initial capital investment and a possible enhancement of project feasibility. The potential for revising criteria in these areas deserves a thorough examination.

CHAPTER III

PROJECTED WORLD FOOD PRODUCTION AND DEMAND: A SUMMARY OF RECENT PROJECTIONS

Recently several analyses of agricultural developments and projections of the world food situation implications to the year 2000 have been prepared. These studies typically have evaluated future supply and demand conditions to be experienced both by the developed and developing countries. The relevance of these projections to this report lies in the implications of projected world food production and demand on U.S. export requirements, or more specifically the increased production that will be required from lands now cropped and the new cropland that will have to be brought into production. The five projections selected for analysis are studies by the Food and Agriculture Organization of the United Nations (FAO), Iowa State University (ISU), the University of California,[1] and two by the U.S. Department of Agriculture (USDA).

THE FOOD AND AGRICULTURE ORGANIZATION

Projections of world agricultural production of selected commodities have been prepared up to 1985 by FAO.[2] The projections cover virtually all of the major agricultural products in the world, including both forest and fishery. Projections of demand were prepared for 60 individual commodities, and of production for 40.

The study analyzed individual countries which, when combined, reflects virtually the entire world population. Production increases stemming from technological advances are incorporated into the work. These advances are assumed to increase at historical rates.

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[1] Except for the one by the University of California, the studies are discussed and compared in a report prepared by USDA. The summaries of the recent projections have been based primarily on this report: U.S. Department of Agriculture, Economic Research Service, The World Food Situation and Prospects to 1985, Foreign Agricultural Economic Report No. 98, Washington, D.C., December 1974.

[2] "Agricultural Commodity Projections, 1970-1980," FAO, Provisional Indicative World Plan for Agricultural Development. Rome: Food and Agriculture Organization of the United Nations, 1970, Volumes 1 and 2 and regional studies, Rome, 1971.

One of the major points emphasized is the increasing difference in grain reserves between the developed and developing countries. The developing countries have grain deficits. By 1985 the net deficit is expected to be 85 million tons. If exports from the major developed countries are excluded, the deficit rises to 100 million tons.

IOWA STATE UNIVERSITY

The Iowa State University report includes projections of world food production, demand, and trade to the years 1985 and 2000.[1] Seventy-three commodities are examined in the study, with projections made for the following categories of food: cereals, sugar, root crops, pulses, fruits and vegetables, oil crops, meat, milk, and eggs. Projections have been prepared by region, with a grouping of countries comprising a region. In total, 96 countries are included. Income for virtually all the countries was calculated by extrapolating historical trends within the individual countries.

As with the FAO projections discussed previously, the ISU study notes a serious discrepancy in grain reserves between the developed and developing countries. Large deficits of grain are foreseen in the developing countries, with large grain surpluses anticipated in the developed nations. By 1985, grain deficits of approximately 115 million metric tons are projected for the developing countries. In the ISU study, the base period is the early 1960's. As a result, the impact of technological advances, specifically those associated with the Green Revolution, on food production is diminished. As an offset to this, large concessionary grain shipments to the developing countries are also assumed.

THE U.S. DEPARTMENT OF AGRICULTURE: 1971

Individual projections have been prepared by USDA for selected major commodities.[2] For this analysis, grain has been selected as the representative

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1 Leroy L. Blakeslee, Earl O. Heady, and Charles R. Farmingham. World Food Production, Demand, and Trade. Ames, Iowa: Iowa State University Press, 1973.

2 Anthony S. Rojko, Francis S. Urban, and James S. Naive. World Demand Prospects for Grain in 1980 with Emphasis on Trade by Less Developed Countries. USDA, FAER-75, December 1971.

commodity. While projections of grain production were published in 1971 to estimate 1980 supply, these projections have since been extended to 1985 by USDA. The conclusion of the projections is similar to the conclusions of the FAO and ISU studies. The developing countries will experience an increasing need for grain by 1985.

Just as the ISU study had weaknesses that do not properly represent the present situation and trends, the USDA projections also are based upon some limiting assumptions. The major shortcoming is that the energy costs used are from the period prior to the "energy crisis," or from the late 1960's. Energy prices, of course, will be significantly higher. These higher energy costs could significantly affect the energy-intensive U.S. agriculture and influence both production and exports.

U.S. DEPARTMENT OF AGRICULTURE, 1974

A later study by USDA provides further insight into world food production and demand.[1] Projections have been prepared for four alternative conditions in order to give more complete predictions. The USDA study reports its findings in terms of production and demand for cereals. Wheat, coarse grains, and rice are the specific commodities examined.

Cereals are vitally important components in the total food picture. Cereal grains now provide about 38 percent of all crop tonnage in the world and almost 75 percent of total food energy. Wheat and rice, the world's two major cereal grains, comprise about two-thirds of the diet in developing countries. These countries are highly dependent on these cereals for direct consumption, whereas only about one-third of the calories in the diets in developed countries comes from the direct consumption of cereals.

The four USDA alternative projections examine major world developments likely to occur. Alternative I assumes strong economic growth, but continued high prices to limit trade. In Alternative II, demand grows faster than in Alternative I for both the developed and developing countries, and trade barriers are reduced. Alternative III assumes economic stagnation well into the 1980's, while Alternative IV assumes that developing countries will increase their food production by obtaining the necessary inputs. Specifically, the addition of 15 million tons of fertilizer and related technology and imports is expected to reduce grain imports of developing countries from 72 million tons in Alternative II, to 16 million tons under Alternative IV.

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[1] The World Food Situation and Prospects to 1985, Economic Research Service, U.S. Department of Agriculture, Foreign Agricultural Economic Report, No. 98, December 1974.

Even in Alternatives I and IV, the more optimistic of the four alternatives, the prospects for world food production and demand are not bright. Alternative I would still require an increase in grain imports for developing countries of 55 million tons, as compared to 20 million tons in 1970-71. Alternative IV assumes developing countries will increase rates of fertilizer use to reduce their dependency on grain imports. Annual rates of increases in the use of fertilizer of 1.0 to 1.5 percent greater than those experienced between 1960 and 1972 were assumed. Where this fertilizer is to come from and who will pay for it are major considerations that decrease the likelihood that this alternative will occur. Clearly, the assistance of the developed countries will be needed to provide inputs, money, and, most importantly, food.

FAO, ISU, and USDA cereal projections, as discussed, are compared in Tables 1 and 2. The first table illustrates the projected tendency for developed countries to produce grain surpluses while deficits accrue in developing countries. The world balance between production and demand, as shown in Table 1, ranged from +46.2 million metric tons in the ISU 1985 projection, to +1.9 million metric tons in the USDA 1985 projection. The balance in developing countries is negative in every case. In the FAO 1985, the USDA base, and the USDA - I 1985 studies, the estimated balances are -76, -23.5, and -58.8 million metric tons, respectively.

Table 2 compares the rates of growth of production and demand for cereals over the period 1969-71 to 1985. For the developing countries, the table clearly shows a growth in demand exceeding the growth in production. On a per capita basis, the discrepancy in growth rates is even greater as a result of the large population increases expected in the developing countries.

UNIVERSITY OF CALIFORNIA

World food supply and demand conditions are evaluated by the University of California for the year 1985 and beyond.[1] The implications of the world food production, consumption, and trade are assessed for the developed and developing countries.

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[1] University of California, A Hungry World: The Challenge to Agriculture, general report by University of California Food Task Force, Division of Agricultural Sciences, University of California, July 1974.

TABLE 1

COMPARISON OF CEREAL PROJECTIONS TO 1985[1]
(million metric tons)

Item	FAO base (1969-71)	FAO 1985	USDA base (1969-71)	USDA-I 1985	USDA-II 1985	USDA-III 1985	USDA-IV 1985	ISU 1985
World								
Demand	1,207	1,725	1,062.6	1,548.5	1,618.7	1,501.8	1,643.9	1,145.5
Production	1,239	NS	1,081.8	1,550.4	1,620.6	1,503.6	1,645.7	1,187.3(L) 1,191.7(H)
Balance[2]	+32	NS	19.2	1.9	1.9	1.9	1.9	41.8(L) 46.2(H)
Developing countries								
Demand	590	929	466.6	691.2	726.2	678.6	743.5	
Production	585	853	443.1	632.4	648.7	626.2	721.0	
Balance	-5	-76	-23.5	-58.8	-77.5	-52.4	-22.5	
Developing market economies								
Demand	386	629	299.7	479.4	512.6	466.7	529.1	524.7
Production	370	544	279.2	424.7	441.0	418.7	513.3	411.0(H) 406.6(L)
Balance	-16	-85	-20.5	-54.7	-71.6	-48.0	-15.8	-113.7(H) -118.1(L)
Asian centrally planned countries[3]								
Demand	204	300	166.9	211.8	213.6	211.9	214.4	
Production	215	309	163.9	207.7	207.7	207.7	207.7	
Balance	+11	+9	-3.0	-4.1	-5.9	-4.2	-6.7	
Developed countries[4]								
Demand	617	796	596.0	857.3	892.5	823.2	900.4	403.4
Production	654	NS	638.7	918.0	971.9	877.4	924.7	574.0
Balance	+37	NS	42.7	60.7	79.4	54.2	24.3	170.6

[1] The data for FAO and USDA are not comparable because FAO carries rice as paddy, USDA carries rice as milled. [2] Imbalances for USDA between demand and production in base are due to stock buildup, timing of shipments, and missing data on a number of small importers. Projected equilibrium does not allow for building or reducing stocks. [3] FAO Asian centrally planned includes the People's Republic of China and other Asian centrally planned countries (North Korea, North Vietnam, etc.) while USDA includes only the People's Republic of China. [4] Includes the USSR and Eastern Europe.

Note: Detail may not sum to total because of rounding.

NS = not shown.

Source: Table 16, p. 35. The World Food Situation and Prospects to 1985, Economic Research Service, U.S. Department of Agriculture Foreign Agricultural Economic Report, No. 98, December 1974.

TABLE 2

COMPARISON OF RATES OF GROWTH OF PRODUCTION AND DEMAND FOR CEREALS FROM 1969-71 TO 1985 [1]
(percent)

Item	Total					Per Capita				
	FAO	USDA-I	USDA-II	USDA-III	USDA-IV	FAO	USDA-I	USDA-II	USDA-III	USDA-IV
World										
Demand	2.4	2.5	2.8	2.3	3.0	.4	.6	.9	.4	1.0
Production	NS	2.4	2.7	2.2	2.8	NS	.5	.7	.2	.9
Developing countries										
Demand	3.1	2.7	3.0	2.5	3.1	.7	.3	.6	.1	.8
Production	2.5	2.4	2.6	2.3	3.3	.2	.02	.2	.05	.9
Developing market economies										
Demand	3.3	3.2	3.6	3.0	3.9	.6	.5	.9	.3	1.1
Production	2.6	2.8	3.1	2.7	4.1	.1	.1	.4	.02	1.4
Asian centrally planned countries [2]										
Demand	2.6	1.6	1.7	1.6	1.7	1.0	.05	.1	.05	.1
Production	2.4	1.6	1.6	1.6	1.6	.8	.03	.03	.03	.03
Developed countries [3]										
Demand	1.7	2.4	2.7	2.2	2.8	.8	1.5	1.8	1.3	1.9
Production	NS	2.4	2.8	2.1	2.5	NS	1.5	1.9	1.2	1.6

[1] Based on data in Table 16

[2] FAO Asian centrally planned includes the People's Republic of China and other Asian centrally planned countries (North Korea, North Vietnam, etc.), while USDA includes only the People's Republic of China.

[3] Includes the USSR and Eastern Europe

Source: Table 17, p. 86. The World Food Situation and Prospects to 1985, Economic Research Service, U. S. Department of Agriculture Foreign Agricultural Economic Report, No. 98, December 1974.

In the developed countries a major influence on food demands is increasing affluence. Better food is demanded as income levels rise. The switch from plant protein to animal protein is typical as a country gains affluence. To illustrate, in most developing countries the average person receives about 400 pounds of grain per year and virtually all of it is consumed directly. In the U.S. grain consumption is equivalent to about one ton per capita, but less than ten percent is consumed directly.

In the developing countries,population is a major factor affecting future world food conditions. Currently, 75 percent of the world's population is in the developing countries. By the year 2000, the amount is estimated to rise to 80 percent, with Asia, Latin America, and Africa fast-growing areas. The net consumption of food in the year 2000 is expected to increase in the range of 68 to 100 percent over 1970 consumption.

The world food production potential depends upon both recent productive trends and natural and man-made constraints. In the developed regions, such as Europe, North America, the USSR, and Oceania, the emphasis has been on increased yields. In the developing regions, particularly Latin America and Africa, greater emphasis has been placed upon the cultivation of new land. The future world outlook relies primarily on seven crops: wheat, rice, maize, soybeans, sugar, potatoes, and pulses. Natural limiting factors to the growth of these crops are the availability of arable land and water, climatic conditions and the problems of salts and siltation. Factors subject to human control include fertilizer, pests and disease, irrigation, labor, energy, mechanization, and the development of new and improved plant varieties.

Food supply and demand are expected to be about equal worldwide in 1985; however, serious regional imbalances will exist. These imbalances have different implications depending upon the regions involved and the abilities to pay for food. For example, Europe and Asia are both expected to be deficient in protein and calories in 1980. Europe has the purchasing power to obtain what it lacks . Asia generally does not.

Table 3 illustrates the 1985 projected calorie and protein imbalances for the regions of the world. Of the regions, only North America and Africa show surpluses in protein and calories. (Oceania is projected to have some surpluses; however,the quantity is negligible.) These surpluses exceed both nutritional requirements and effective demand. Latin America, Asia, Europe, and the USSR are deficient in both calories and protein. In Asia and Latin America the problem does not appear great on a percentage basis. Yet, these regions have high population growth and low productivity and per capita incomes, and these factors significantly affect chances for improvement in the food situation. Although Africa shows an overall balance, shortages will occur in certain countries and for certain crops.

TABLE 3

PROJECTED CALORIE AND PROTEIN BALANCES BY REGION

Region	Needs as an Approximate Percentage of Production: Food Demand	Total Demand 1/	Adequate Food Supply
World			
Calories	75	100	75
Protein	90	110	60
Asia			
Calories	90	105	90
Protein	105	115	70
Europe			
Calories	80	140	65
Protein	130	210	55
U.S.S.R.			
Calories	75	110	50
Protein	65	120	30
Latin America			
Calories	65	105	65
Protein	65	90	25
North America			
Calories	35	70	30
Protein	50	70	45
Africa			
Calories	70	90	80
Protein	70	90	45

Source: University of California. Division of Agricultural Sciences. A Hungry World: The Challenge to Agriculture. Summary Report by U. C. Food Task Force, Berkeley, California, July 1974.

1/ Total demand is the sum of demand for food and non-food uses, such as industrial uses.

The implications of the University of California report for the world food situation are somewhat uncertain. Nevertheless, several points can be made. The distribution of food is a more serious problem than total world food production. Population growth rates have exceeded productive increases and will continue to do so at least up to 1985. Shortages will continue in the developing regions of Asia, Latin America, and Africa. Finally, most of the best farming lands are already being farmed. The development of the remaining arable land will be much more difficult.

WORLD CONDITIONS FOR AGRICULTURAL PRODUCTION

The general outlook for future agricultural production gives cause for concern. The prices of fertilizers, pesticides, fuel and machinery are going to rise. Developing countries with already meager foreign exchange earnings will find purchasing modern farm inputs such as fertilizers, chemicals and fuel increasingly difficult. In the developing countries, population will generally continue to grow at the present high rates. Population increases in the developed countries will be lower.

The implications of the five studies examined for the future are varied. Certainly, a number of developments will have to occur to solve the problems of world food production and distribution. The developing countries will need to reduce their high rates of population growth and increase their food production.

The dependence of the developing countries on imports of food up to the year 2000 will increase. In all likelihood, the demands for food from the developing countries will be a significant factor well into the 21st century. Export demands for grains in 1985 in the developing countries are projected at approximately 50 million metric tons, as compared with 20 million tons in 1970/71.

Additional supplies from major food exporters, such as the United States, will require modifications in agriculture. Further technological development will no doubt occur, although in recent years the rate of increase has declined. The prospect is that a substantial portion of the output will have to come from the addition of new cropland to production.

CHAPTER IV

THE 1975 NATIONAL WATER ASSESSMENT AGRICULTURAL PROJECTIONS

The United States Water Resources Council has prepared national projections of agricultural production and of the corresponding increases in acreages of harvested cropland. This work is a part of the 1975 National Water Assessment (NWA). The NWA will ultimately assess the adequacy of the existing water supplies relative to water needs. It will also evaluate the economic, environmental, and social implications of water shortages. These implications will be analyzed for several alternative future policy conditions. The analysis is conducted for 106 geographic units known as aggregated subareas (ASA). These 106 ASA's, in turn, are aggregated into 20 national water resource study regions (See Maps 1 and 2). The NWA agricultural projections are scheduled for completion in June 1977. When completed, the projections will cover seven policy alternatives related to exports, resource management, and energy development. At present, preliminary results are available for the first three options, two based on historical trends and one on assumptions of high exports.

The NWA projections have an advantage over the five previously selected projections as increases in harvested acreage are tied to the production projections. They also have an important advantage as they tie the areas of increased harvested acreage to the 160 aggregated subareas throughout the United States and thereby indicate the geographical areas of likely expansion.

The NWA agricultural projections are based on a series of three historical projections prepared by the USDA Economic Research Service (ERS) using the National Inter-Regional Agricultural Projections (NIRAP) computer model. These ERS projections and the NIRAP model will be combined with the national linear programming (LP) model developed by Iowa State University. The LP model adds the capability to analyze resource management and energy development policies as they may affect the use of land and water resources and, consequently, total agricultural production.

In the following sections, the ERS production projections will be discussed first. Following will be discussions of the NWA projections and a summary of the preliminary results.

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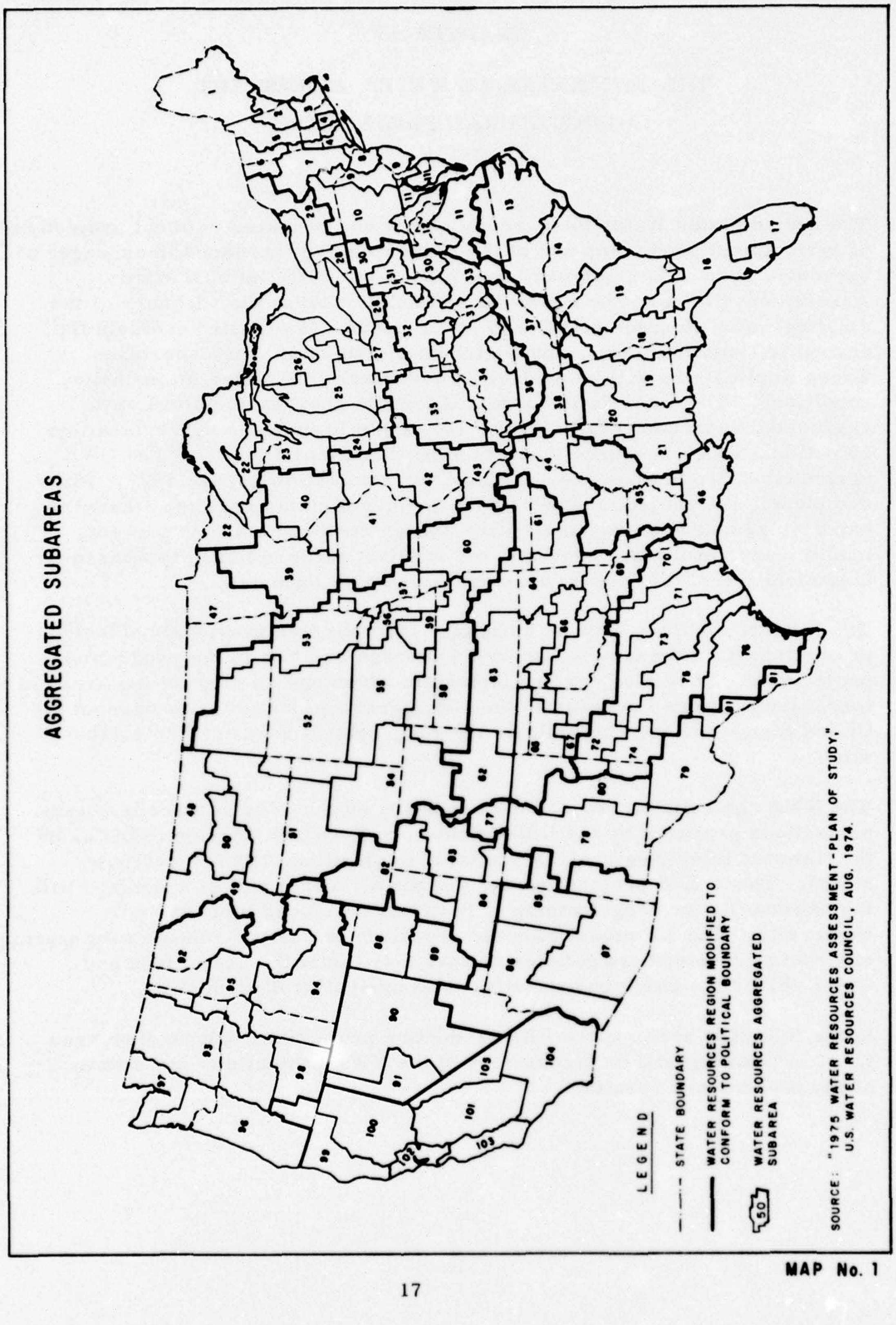
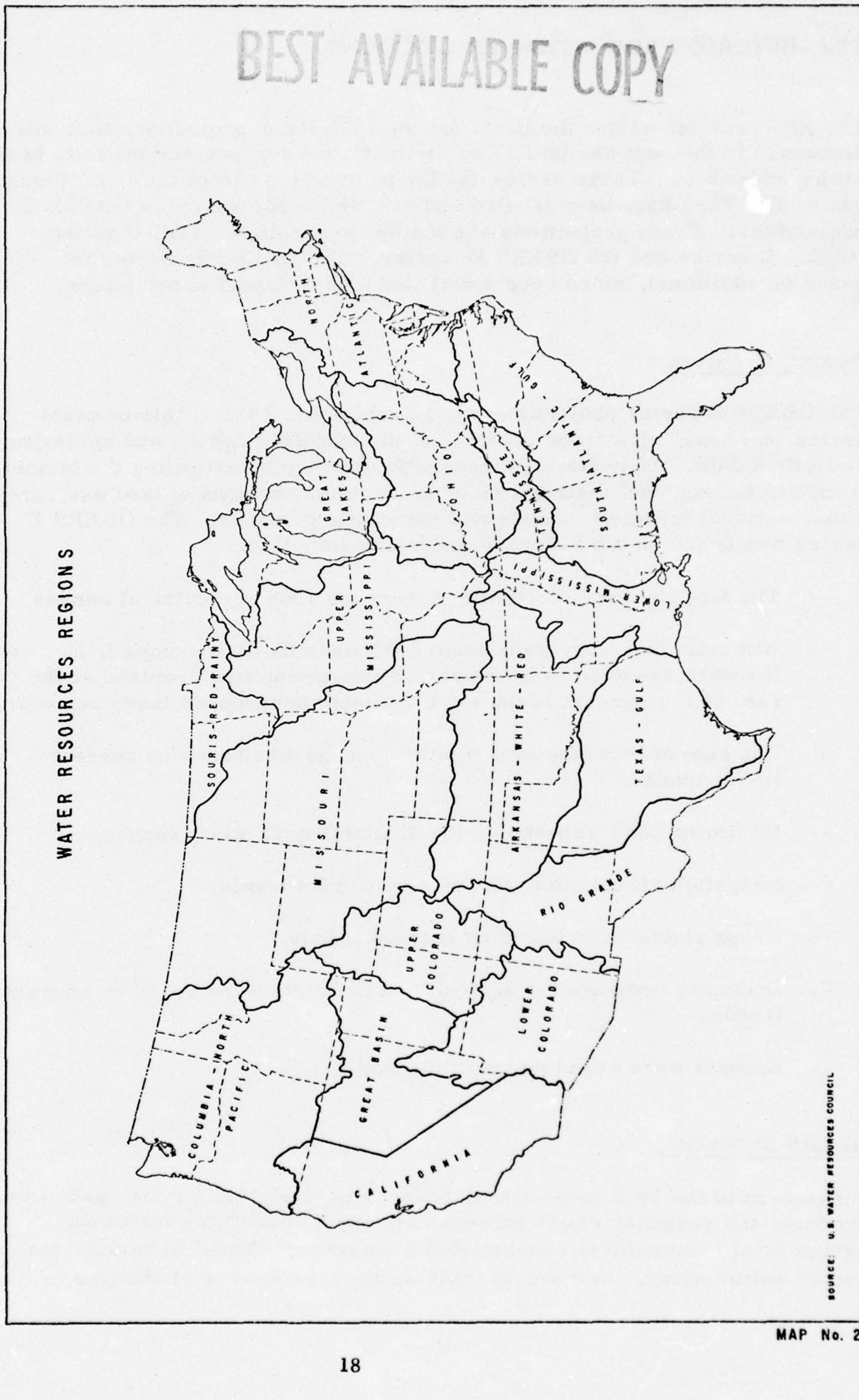


MAP No. 1


WATER RESOURCES REGIONS
NORTH ATLANTIC
SOUTH ATLANTIC - GULF
GREAT LAKES
OHIO
TENNESSEE
UPPER MISSISSIPPI
LOWER MISSISSIPPI
SOURIS - RED - RAINY
MISSOURI
ARKANSAS - WHITE - RED
TEXAS - GULF
RIO GRANDE
UPPER COLORADO
LOWER COLORADO
GREAT BASIN
COLUMBIA - NORTH PACIFIC
CALIFORNIA
SOURCE: U.S. WATER RESOURCES COUNCIL

MAP No. 2

ERS HISTORIC PRODUCTION PROJECTIONS

The ERS projections are the basis for the 1975 NWA projections that will be discussed in the next section. Two distinct series of projections have been prepared by ERS. These series used population data from the U.S. Census Series E. They have been labeled and are commonly known as OBERS E projections. These projections are further generally classified as the OBERS E series and the OBERS E' series. The OBERS E' Series is based on additional, more recent data and higher export assumptions.

OBERS E Series

The OBERS E Series projections were prepared in 1972. This original series was based on a trend analysis of the available census and agricultural statistical data. The data were generally obtained by extending the historical trends in the regional distribution of production, patterns of land use, crop yield, national levels of exports and per capita demands. The OBERS E series was based on the following general assumptions:

-- The land base was determined from the 1969 agricultural census.

-- Wet soils and other soils from land classification groups I, IIe, and IIw were assumed to be converted into productive cropland at the rate of 1.5 percent of the total available noncropped lands per year.

-- The rate of increase in irrigated acreage was based on current (1972) trends.

-- No limits were imposed on the availability of water supplies.

-- Irrigation efficiencies were set at current levels.

-- Crops yields were based on current trends.

-- Domestic demands for agricultural products were based on current trends.

-- Exports were based on current trends.

OBERS E' Series

Subsequent to the 1972 projections, changes in export policy for agricultural products and resulting major increases in export quantities for basic agricultural commodities necessitated a major adjustment in agricultural export assumptions. In order to indicate the significance of changes in

the export market, the OBERS E' Series projections were made in the summer of 1974. The Series E' projections were made at two levels -- the Series E' Baseline Export Level and a Series E' High Export Level.

OBERS E' Baseline Export Level Projections -- These were based on additional domestic demand and export data and included the following assumptions:

-- The world capacity for cereal production will increase faster than consumption into 1985.

-- Grain stocks will be rebuilt, causing downward pressure on prices, programs will restrict production in major exporting countries, or some combination of these will occur.

-- The enlarged European community, Eastern Europe and USSR will approach grain self-sufficiency.

-- Continuation of policies to maintain high prices in the European community will encourage substitution of protein supplement and other nongrain feeds for grain.

-- The people in the Republic of China will likely import wheat and export rice, while Japan will remain the largest single import market for wheat and coarse grains.

OBERS Series E' High Export Projections -- These were based on the assumption that the rising affluence of less developed countries and improvement of their diets, coupled with a vigorous U.S. export policy to stabilize and improve the balance of trade, will cause substantial increases in U.S. exports. The projections are more specifically based on the following export assumptions:

-- The USSR and Eastern Europe will increase livestock production and consumption at faster rates of growth, with grain imports and a high overall level of trade with the Western World.

-- The people in the Republic of China will become more trade oriented and will import more grain to improve diets.

-- The European community will find it advantageous to pursue self-sufficiency less strongly by setting lower price targets for production, thus permitting continued imports of grain.

-- Livestock demands, particularly for the developing world, will go faster in countries experiencing unprecedented higher rates of economic growth, e.g., countries with enhanced petroleum revenues

-- Fish meal production will remain at 1969 to 1971 levels

The net agricultural export levels projected by the various OBERS Series projections are summarized in Table 4.

NATIONAL WATER ASSESSMENT PROJECTIONS

The NWA projections combined the OBERS E and OBERS E' Series NIRAP model projections as previously described, with several resource management options. These options are included by combining the NIRAP model with the LP model developed by Iowa State. This combined model,developed by the ERS in collaboration with Iowa State University,is generally known as the Agricultural Resources Assessment System or, in brief, the NIRAP/LP Model. In addition to the resource management options, the final NWA projections will use a different resource data base.

The final NWA models will include seven alternative future situations projected by the Agricultural Resources Assessment System. Of these seven, four variations of three cases have been analyzed and were published in a preliminary report in October 1975. These three cases include a Central Case that has been based on the OBERS E Series projections, a case based on the OBERS Series E' Baseline Projections, and the Modified Central Case, based on OBERS E' Series High Export Projections. The remaining, presently unavailable projections include the resource and conservation policy aspects of the projections. These will include cases to identify the effects of land and water conservation, the effects of environmental enhancement, the effects of energy resource development and a critical case based on the most constraining combination of the three resource and conservation policies.

The October 1975 preliminary results actually consist of the following four cases:

-- The NWA Central Case

-- A modification of the Central Case - the OBERS E/LP Projection. This projection uses the older 1972 ERS data base rather than the NWA data

-- A modified Series E' Case, the OBERS E'/LP Projection. This projection uses the 1974 OBERS E' Baseline data base rather than the NWA data base

-- The NWA modified Central Case

TABLE 4

PROJECTIONS OF NET AGRICULTURAL EXPORT LEVELS FOR UNITED STATES: OBERS SERIES E, AND SERIES E' BASELINE AND HIGH EXPORT 1/

Commodity	Unit	1970-72 Average	OBERS E			Series E' Baseline		Series E' High export	
			1985	2000	2020	1985	2000	1985	2000
		Million							
Wheat	Bu	737	785	814	855	774	919	1179	1479
Rice	lb	5200	6227	6550	7010	6990	8600	7400	9400
Soybeans	Bu	443	599	684	752	950	1475	1125	1700
Corn	Bu	663	1118	1275	1403	989	2069	1889	3209
Grain sorghum	Bu	160	202	217	239	160	380	270	450
Oats	Bu	14	5	4	4	10	21	19	29
Barley	Bu	43	93	96	101	20	35	25	40
Rye	Bu	1	7.4	7.7	8.1	7.4	7.7	7.4	7.7
Peanuts	lb	346	751	806	887	750	805	750	803
Cotton	lb	1970	1680	1680	1680	1970	2020	2020	2210
Sugar	Tons	-5.60	-5.56	-6.24	- 9.4	- 5.5	- 6.2	5.5	- 6.2
Tobacco	lb	400	610	610	610	318	376	318	376
Citrus fruit	lb	2119	3120	3200	3418	3208	3494	3253	3494
Noncitrus fruit	lb	-2008	-1680	-2300	-2418	-2276	-2659	-2276	-2659
Vegetables	lb	- 798	- 509	- 535	- 572	- 509	- 535	- 509	- 535
Irish potatoes	cwt.	4.0	2.0	2.0	2.0	2.1	2.1	2.1	2.1
Sweet potatoes	cwt.	.1	-	-	-	.1	.1	.1	.1
Dry beans	lb	399	595	595	595	595	595	595	595
Dry peas	lb	324	105	105	105	105	105	105	105
Flaxseed	Bu	4.7	10	10	10	10	10	10	10
Beef and veal	lb	-1740	-2163	-2909	-3906	-2169	-2924	-1190	-1760
Pork	lb	- 278	- 275	- 325	- 425	- 307	- 351	- 307	- 351
Lamb and mutton	lb	- 117	- 184	- 203	- 220	- 230	- 274	- 230	- 275
Chicken	lb	203	133	90	85	235	253	235	253
Turkey	lb	31	35	35	35	70	80	70	80
Eggs	doz.	40	43.9	50.0	50.0	43.9	50.0	43.9	50.0
Milk	lb	- 500	- 500	- 500	- 500	- 680	-1040	- 680	-1040

1/ Projected exports based on revised estimates by ERS international trade analysts, June, 1974.

Source: Table entitled "Comparison of alternative net export levels, OBERS E, NEAD E' revised baseline and NEAD E revised, high export."
Economic Research Service, U.S. Department of Agriculture, Washington, D.C.; 23 August 1974.

The following sections outline the assumptions underlying the seven alternative future projections. Emphasis is on four cases projected in the NWA's 1975 work projections and the Series E' projections.

NWA Central Case Projection

The following assumptions define the NWA Central Case projections:

-- The land area is based on the 1967 conservation needs inventory updated to 1973 for irrigation acreage and the acreage of converted wet soils. Bureau of Reclamation projects were also projected to indicate facilities constructed and in operation by 1985 and 2000.

-- The irrigated acreage in each ASA was assumed to be identical to those used in the 1972 OBERS E studies.

-- The conversion of wet soils to cropland from uncropped Class II_w and III_w lands was allowed to occur at the 1967 to 1973 conversion rates up to a maximum acreage of 90 percent of the 1967 Conservation Needs Inventory totals for noncrop land in these classes.

-- The water supply was assumed to be unlimited. Deficits in water supply determined by volume metric analysis were to be noted.

-- Irrigation efficiencies were based on current practices.

-- Crop yields were projected through the Iowa State Linear Programming Model.

-- The domestic demand for agriculture products was based on the OBERS E determinations of per capita consumption rates.

-- Exports were based on the OBERS E' export projection.

-- Erosion limits are set at ten times normally accepted standards for allowable erosion rates for the given soil,but they are not allowed to exceed 40 tons per acre.

-- Livestock wastes were not restricted either for use or disposal.

-- Regional adjustment constraints were set so that the individual crop acreage in each aggregated subarea was allowed to decrease to 70 percent of the 1969 Agricultural Census acreage by 1985 and to 40 percent of the census acreage by 2000.

The Central Case, as defined by the above material, was developed to establish a baseline condition against which alternative future policy assumptions are evaluated. Accordingly, for the purpose of this work the assumptions for the remaining future alternative conditions will not be outlined in detail. Rather, the assumptions differing from the central case will be noted.

NWA OBERS E/LP Projection

In addition to the Central Case Projections, the 1975 studies contained a separate projection similarly based on the OBERS E 1972 projection. The principal difference between the 1975 NWA OBERS E Projection and the Central Case projection is the data base. For the 1975 NWA OBERS E/LP projection, the 1972 OBERS E data base was retained. This modification results in the differences from the Central Case as follows:

-- Land resource base

-- Rates of conversions of wet soils

-- Determinations of irrigated acreage

-- Determinations of crop yields

NWA Projection Series E'

The Series E' projections are similar to the central case projections except that higher commodity demands in export levels have been assumed. These increases and commodity demands in export levels are the same as those discussed for the ERS Series E' baseline projections. This case was not included in the 1975 study results. The assumptions are as follows:

-- The irrigated acreage was determined from the 1967 conservation needs inventory acreage updated to 1973 with Bureau of Reclamation irrigation projects as projected to be in place by 1985 and the year 2000. In addition, the linear programming model adds private irrigation developments as they are substantiated within the limits of the program logic.

-- The water supply for this projection is assumed to be equal to the quantities available for agricultural use in 1975. The total water supply, however, is limited to indicate declining groundwater reserves.

-- Domestic demand for agricultural commodities is based on the ERS OBERS Series E' per capita consumption rates.

-- The levels of exports of agricultural commodities are the same as determined for the ERS OBERS Series E' "normal historic" export levels.

NWA OBERS E'/LP Projection

In the 1975 studies, a projection for an OBERS E'/LP Case was run. This case is similar to the NWA Series E' Projection. However, the base data are based on the 1974 OBERS E' projection. Differences in assumptions between the OBERS E' Series and the OBERS E'/LP projection would be identical to those listed under the preceding section describing the OBERS E/LP Projection.

NWA Modified Central Case Projection

The modified central case projection is similar in all respects to the NWA Series E' case with the exception of the level of exports. The levels of exports assumed for the Modified Central Case option are the same levels as assumed for the 1974 ERS Series E' High Export Projection.

Future NWA Projections

The NWA program for agricultural projections will include four additional alternative future conditions. These projections, although not now available, are scheduled for completion by June 1977. These alternative future runs are most easily described by comparison with the NWA Series E' projection. The similarity extends both to the data bases used and, in most cases, to the level of exports assumed. The future alternative policy projections and the underlying assumptions of each are as follows:

-- Land and water conservation alternative -- This alternative assumes a policy for reducing erosion from agricultural lands and improving irrigation efficiency through reduction of phreatophyte growth and reductions in canal losses. These policies are reflected through increases in irrigation efficiencies and long-term reductions in allowable soil erosion rates of three to five tons per acre.

-- The environmental enhancement alternative -- This alternative assumes that Agricultural Land Classes IIw and IIIw will be reserved for environmental enhancement and that conversion to cropland uses will not be allowed. Irrigation water supplies will be reduced to maintain minimum stream flows as required for water quality and the protection of aquatic life. Further, all livestock wastes will be returned to agricultural land.

-- Energy development alternative -- This alternative assumes that land and water supplies now available for agriculture would be reduced by land conversions for energy development. More particularly, existing grazing and cropland would be used for oil shale extraction and strip mining of coal. Additionally, available water supplies would be shifted from irrigation use to meet greater needs in the development of energy sources and production of energy.

-- Critical condition alternative -- This projection combines the most limiting and demanding assumptions used under the preceding three policy restrictions. This case also assumes the OBERS E' Series high export condition.

PRELIMINARY RESULTS -- 1975 NATIONAL WATER ASSESSMENT

The preliminary information generated by the NWA Agricultural Resources Assessment System projections is as follows:

1. Agricultural land use divided into cropland harvested, total cropland, total agricultural land, and total irrigated areas by crop and land use type.
2. Agricultural production for selected crops and livestock.
3. Value of production for selected crops and livestock.
4. Irrigation water use.
5. New cropland development for irrigated and drained lands.
6. Net agricultural earnings for the principal water resource regions.
7. Agricultural employment for the principal water resource regions.
8. The value of additional units of dry and irrigated land (by class) brought into production.
9. The soil erosion loss for different classes of dry and irrigated land.
10. Changes in harvested cropland by water resource region.
11. Irrigated and drained lands that will be developed for cropland.
12. Wetland conversions by water resource region.

Of the above items, 2, 5, 10, 11 and 12 are considered germane to the objectives of the study. A discussion of these findings follows.

Preliminary NWA production projections show a substantial increase in agricultural production in the United States from 1975 to 1985 and 2000.

The projections for major crops and livestock are shown in Table 5. All projections show corn to be the crop in highest production through 2000. Increases in 1975 U.S. corn production range from four to 18 percent for 1985 and from two to 56 percent for 2000. Soybeans show the largest production increases. Increases in 1975 U.S. soybean production range from 47 to 175 percent for 1985 and from 67 to 165 percent for 2000.

When compared to the world production projections to 1985 in Chapter II, the United States is shown to continue to produce approximately 25 percent of the total world cereals. As shown in Table 6, the range is between 19 and 28 percent regardless of the various assumptions used for projections. When coupled with ever-increasing world demand, the indication is clear that U.S. production must increase substantially if world demand is to be met.

Implications for Land Use

Increases in production to the levels indicated to be necessary can come about in three basic ways:

-- increases in cropland

-- advances in technology

-- more intensive use of the land, including irrigation and double cropping

Changes in Acres Harvested

The projections for agricultural land use are shown in Table 7. NWA projections for cropland show a net decrease in total cropland regardless of the assumptions imposed. Decreases in 1975 total cropland range from 14 percent to less than one percent for 1985 and from 15 percent to less than one percent for 2000. The projections indicate that if dramatic production increases are to occur they must come from technology or more intensive use of the land. A majority of the increases is expected to come from more intensive use of the land.

TABLE 5

UNITED STATES AGRICULTURAL PRODUCTION BY COMMODITY GROUPS, 1975, AND HISTORIC TRENDS TO 1985 AND 2000

COMMODITY	UNIT	1975 [1]	-- 1985 -- CENTRAL CASE	OBERS E LP	OBERS E'/MCC LP	-- 2000 -- CENTRAL CASE	OBERS E LP	OBERS E' LP	MCC
					(Millions) [2]				
Crops:									
Corn	BU	5,610	6,610	6,066	5,800	8,731	5,733	6,939	7,109
Grain Sorghum	BU	873	1,131	917	1,043	1,562	654	838	996
Oats	BU	745	884	919	952	1,036	554	645	793
Barley	BU	437	549	653	1,040	654	494	581	702
Hay	TONS	130	139	320	342	361	102	342	386
Silage	TONS	151	145	153	125	163	390	434	265
Wheat	BU	1,619	1,763	1,529	1,710	2,006	1,617	1,693	1,688
Rice	CWT	35	39	28	39	47	28	47	47
Rye	BU	88	118	99	118	148	108	148	148
Fruits	CWT	22	24	25	24	27	29	27	27
Sugar (Raw)	TONS	4	6	4	6	7	5	7	7
Vegetables and Melons	LB	435	567	541	567	659	602	659	569
Irish and Sweet Potatos	CWT	316	368	344	368	421	384	421	421
Dry Beans and Peas	LB	18	22	27	22	21	28	21	21
Tobacco	LB	1,741	2,140	1,965	2,140	2,097	2,064	2,097	2,097
Cotton	BALES	12	10	11	10	10	11	10	10
Soybeans	BU	1,336	2,061	1,964	2,475	2,909	2,227	3,547	3,451
Peanuts	LB	3,242	4,813	4,149	4,813	6,390	4,690	6,390	6,390
Flaxseed	BU	16	28	24	28	25	21	25	25
Livestock:									
Beef and Veal (carcass)	LB	23,088	28,680	28,468	29,698	35,237	32,509	36,613	36,613
Pork (carcass)	LB	12,670	14,346	14,877	15,568	16,906	16,728	18,407	18,407
Lamb and Mutton (carcass)	LB	472	177	452	177	160	457	160	160
Chickens (ready-cook)	LB	8,809	11,972	11,530	11,972	15,190	13,838	15,190	15,190
Turkeys (ready-cook)	LB	1,829	2,537	2,486	2,537	3,330	2,943	3,330	3,330
Eggs	DOZ	5,718	6,352	6,332	6,352	7,025	6,981	7,025	7,025
Milk	CWT	1,178	1,210	1,087	1,185	1,208	1,175	1,187	1,187

1 1971-73 Average

2 Less than 1.0 percent of United States Production Recorded as zero.

TABLE 6

NWA US CEREAL PRODUCTION PROJECTIONS AS COMPARED TO WORLD CEREAL PRODUCTION PROJECTIONS TO 1985

NWA Projections	FAO		USDA 1/		ISU 2/		Range of Projected U.S. Cereal Production as a Percent of World Production	
	Base Year	1985	Base Year	1985	Base Year	1985	Base Year	1985
	Percent							
Central Case	22	-	25	20	25	28	22-25	20-28
OBERS E	22	-	25	19	25	26	22-25	19-26
OBERS E	22	-	25	21	25	28	22-25	21-28

1/ USDA -IV projections

2/ ISU high export model

TABLE 7

AGRICULTURAL LAND USE, 1975, AND HISTORIC TRENDS, 1985 AND 2000, UNITED STATES

LAND USE	1975[1]	-- 1985 -- CENTRAL CASE	OBERS E LP	OBERS E'/MCC LP	-- 2000 -- CENTRAL CASE	OBERS E LP	OBERS E' LP	MCC
				(Thousand Acres)				
Cropland Harvested[2]	302,566	285,790	280,176	318,834	271,325	248,672	326,539	353,554
Feed Crops:								
Grains[3]	100,738	99,779	94,276	100,712	91,142	71,358	89,828	95,440
Roughage[4]	72,820	67,445	57,771	66,719	64,396	57,760	75,044	79,410
Food Crops:								
Grains[5]	51,166	42,735	44,774	52,046	40,263	39,865	45,553	46,026
Vegetables, Fruit and Sugar	9,405	8,963	8,933	9,546	9,108	9,125	9,963	10,866
Other[6]	2,936	3,000	3,076	2,855	2,884	2,970	2,692	2,683
Other Crops:								
Oilseeds[7]	51,126	52,521	58,513	73,366	52,489	56,391	91,074	86,392
Cotton, Tobacco, Misc.	18,006	14,750	13,158	13,919	14,235	11,535	12,725	12,676
Cropland Not Harvested[8]	156,487	172,393	113,680	78,066	186,992	148,658	72,438	65,366
TOTAL CROPLAND	459,054	458,184	393,857	396,800	458,318	392,331	398,979	398,920
Private Forest and Woodland Grazed	108,224	103,146	26,860	26,860	95,755	26,652	26,652	26,652
Pasture, Range and Other Land[9]	801,467	785,007	782,392	776,875	789,417	776,141	762,795	763,094
Non-Rotation Hayland[10]	0	0	134,317	134,317	0	133,440	133,440	133,440
TOTAL AGRICULTURAL LAND	1,360,832	1,348,095	1,337,426	1,334,953	1,331,801	1,328,563	1,321,867	1,322,106
Irrigated Cropland Harvested[2]	35,644	37,249	34,013	36,737	37,120	33,563	37,673	36,148
Feed Crops:								
Grains[3]	9,678	10,112	9,202	10,516	9,833	4,551	4,340	5,190
Roughage[4]	9,442	10,799	12,120	11,669	11,185	16,985	19,364	16,613
Food Crops:								
Grains[5]	4,260	4,052	2,724	3,869	3,850	3,390	4,697	4,518
Vegetables, Fruit and Sugar	5,759	5,964	5,102	6,116	6,218	4,944	5,146	6,018
Other[6]	1,191	1,191	1,276	1,260	1,229	1,319	1,297	1,274
Other Crops:								
Oilseeds[7]	1,020	1,095	515	607	1,131	230	506	390
Cotton, Tobacco, Misc.	4,614	4,458	3,401	3,028	3,965	2,477	2,662	2,484
Irrigated Non-Rotational Hayland, Pasture and other[10]	4,515	5,449	9,165	4,342	5,523	9,122	3,815	4,554
TOTAL IRRIGATED LAND	40,159	42,698	43,179	41,079	42,642	42,685	41,488	40,702

1 1971-73 Average.
2 Cropland harvested will not equal the sum of crops harvested due to double cropping on irrigated land.
3 Corn, grain sorghum, oats, and barley.
4 Hay and Silage.
5 Wheat, rye, and rice.
6 Irish and sweet potatoes, dry beans, and dry peas.
7 soybeans, peanuts, and flaxseed.
8 1975 and central case 1985 and 2000 projections include fallow, cropland pasture, idle and crop failure.
9 Includes BLM and Forest Service Land. Other land is land used for farmsteads, roads, ditches, ponds and wasteland.
10 Included in feed crops: roughage for 1975 and central cases.

Changes in Land Use

Irrigation and draining and clearing wet soils are two main factors affecting changes in land use reported in the NWA projections.

These two types of land conversion have implications for flood plain lands due to the relationship of wet soils to low-lying flood plain lands and the benefits of locating irrigation facilities close to water sources.

Table 8 summarizes new cropland developed from these two sources according to the NWA Modified Central Case (MCC), which includes the high export assumption and can be considered an upper limit. An important consideration in these projections is that they do not show the effects of environmental, energy and conservation policies. This consideration could significantly reduce the rate and total amount of wetlands and irrigated lands converted.

Table 8 shows the development of 6.7 million acres of new irrigated lands by 2000 as projected by the MCC. According to Table 7, the total increment of irrigated lands by 2000 will be 543,000 acres. This indicates that while 6.7 million acres is being developed, 6.2 million will be taken out of irrigation and probably out of production. This result should be viewed cautiously since national trends show substantial net increases in irrigated acres except for small decreases in the Rio Grande Water Resources Region.

The MCC predicts 10,492,000 acres of new cropland will be developed through draining and clearing. Approximately 45 percent (4,699,000 acres) of the projected new cropland to come from wet soils is located in the Southeast, encompassing the Tennessee, Lower Mississippi and South Atlantic-Gulf Water Resource Regions. An additional 27 percent (2,774,000 acres) of the new cropland obtained by clearing and draining wet soils is projected to occur in the North Central and 20 percent (2,091,000 acres) in the Northeast. Thus, over 90 percent (9,514,000 acres) is within these regions.

The high export MCC agricultural land use projections from Table 7 show a 13 percent (60 million acre) decrease in total cropland in the year 2000. Therefore, while 10.5 million acres of wetlands is being brought into production, 60 million total cropland acres is going out. Since the total cropland projection is based on historical data, the decrease is consistent with the national trend, i.e., cropland decreases.

Implications for Changes in Land Use

The most obvious implications of the NWA land use projections are that marginal lands or lands located on urban fringes will go out of production. Good lands for reclamation projects and uncropped Class I and II lands

TABLE 8

PROJECTIONS OF NEW CROPLAND DEVELOPMENT:
NWA MODIFIED CENTRAL CASE CONDITIONS 1975-2000

		New Cropland Developed (acres)	
Major Region	Water Resource Region	Irrigated Lands	Draining and Clearing Wet Soils
Northeast	New England, Middle Atlantic, Ohio, Great Lakes	0	2,091,000
Southeast	Tennessee, Lower Mississippi, South Atlantic-Gulf	0	4,649,000
North Central	Souris-Red-Rainy, Upper Mississippi, Missouri	2,724,000	2,774,000
South Central	Arkansas-White-Red, Rio Grande, Texas Gulf	1,543,000	978,000
Northwest	Columbia-North Pacific	1,362,000	-
Southwest	California, Great Basin, Upper and Lower Colorado	1,047,000	-
		6,676,000	10,492,000

will be brought into production. The total land area will decrease, but yields will increase due to the use of better land for production and technological advances.

The Corps' role could be to reclaim good lands currently marginal due to flood damage. Adequate drainage ways may have to be provided when poor drainage is a constraint to production. The economic trade-offs will need to be identified project by project.

At present, the economic trade-offs on how much land will be needed to meet world food demands cannot be quantified. This fact will become apparent in the following two chapters of this report as relevant data is identified.

The Corps should emphasize the examination of flood plains where larger shifts in land use are now occurring. Careful consideration should be given to production projects considered marginally feasible prior to reclamation in order to determine the economic impacts of flood protection and drainage.

An Additional Consideration

An important factor in the projected conversion of wetlands into agricultural uses, and one not considered in the model, is Section 404 of PL 92-500, the 1972 Amendments to the Federal Water Pollution Act. Section 404 gives the U.S. Army Corps of Engineers the responsibility of regulating the discharge of dredged or fill material in the waters of the United States. As originally planned, Corps authority would expand in a three-phase program over the next two years. Phase I, which became effective in July 1975, gave the Corps authority over traditional navigable waters and adjacent wetlands. Phase II would extend Corps authority to primary tributaries of navigable waters, lakes, and contiguous or adjacent wetlands. Phase III would extend authority to all waters in the United States.[1]

Phase II was to become effective on July 1, 1976, while Phase III was set to begin in July 1977. However, by executive order, the start of Phase II has been delayed until September 1, 1976. An amendment is currently in the Congress which would stop the extension of Corps authority, and limit such authority only to navigable waters in the United States.

The present uncertainty over the permit program makes it difficult to assess the potential impacts of Section 404 on the projected conversion rate of wetlands into agricultural uses. Yet, regardless of the type of waters

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[1] U.S. Army Corps of Engineers, "Section 404 Permit Program", general information handout, September 1975; pp 1-2.

included in the program, it is known that both private individuals and government agencies are subject to regulation. Government agencies that dam major streams, build dikes, or discharge dredge or fill materials into wetlands in the course of farming will need a permit, in addition to having to file an environmental impact statement. Farmers engaged in the same activities in the course of farming will also need a permit. Exempted are normal farming practices, such as plowing, seeding, harvesting, or cultivating, as well as the construction of drainage and irrigation ditches.[2] Corps of Engineers' projects will not be affected by Section 404 because the Corps does not require permits of itself, and because Corps projects already undergo intensive study and public hearings to determine potential adverse effects.

New cropland to be developed over the period 1975-2000 as a result of clearing and drainage is projected at 10,492,000 acres in Table 8. This projection admittedly does not include the effect of environmental or conservation policies, and, as mentioned previously, this consideration could significantly reduce the rate and total amount of wetlands and irrigated lands converted. Specifically, it is expected that Section 404 will restrict the conversion of wet soils to cropland. Theoretically, all ten million acres projected could be restricted, and no new cropland would be developed in the future from wetlands. Given the uncertainty of the water areas included in Section 404, the level of enforcement to be administered, and the acres of new cropland which would be created by Corps of Engineer rural flood control projects, it is not possible to give a quantitative estimate of the national acreage restriction resulting from Section 404. It is anticipated, however, that a substantial portion of the new cropland acreage projected by the National Water Assessment will have a restriction on conversion.

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2 National Archives, Federal Register, "Permits for Activities in Navigable Waters or Ocean Waters", Vol. 40, No. 144, July 25, 1975; pages 31,321 and 31,325.

CHAPTER V

PROGRAM DATA OF THE CORPS OF ENGINEERS

INTRODUCTION

The status of rural lands in Corps of Engineers flood control and drainage programs can be ascertained from program data located in the Office of the Chief. The primary source of program data, and the source most relevant to the scope of this study, is the Planned Programming Budgeting System (PPBS) computer record. The evaluation and analysis of the PPBS data will comprise most of this chapter.

Additional data located within the Office of the Chief provide estimates of total flood plain lands. This information will be included to furnish an overview of the information contained in the computer record. Additionally, this chapter will provide an in-depth examination of the lower alluvial valley of the Mississippi River. The Valley was chosen for illustrative purposes because of its major importance to the Corps as a site of flood protection for millions of acres of rural land. From this example, information can be drawn pertaining to agricultural use and the status of flooding and drainage conditions for flood plains where Corps projects have provided varying degrees of protection.

PPBS COMPUTER RECORD

Various aspects of Corps programs and policies relating to flood control and drainage are reflected in the PPBS record which is recorded on computer tape. Program data on the status of rural lands in Corps of Engineers flood control and drainage projects are recorded on the computer tape. The computer record contains information on lands protected by existing projects and by planned projects. Virtually all of the data analyzed came from the computer record as of September 30, 1975. Earlier data are primarily concerned with lands already protected, particularly the agricultural and drainage status of lands protected by the Corps projects as of December 1971.

The examination of the agricultural and drainage status of lands at a national level provides some perspective on work already completed by the Corps and on future work planned. Information from 1957 and 1971 shows the development of Corps projects and the changing needs for drainage and the preparation of agricultural lands.

Drainage and Agricultural Status at the National Level

An early analysis of the agricultural and drainage status of rural lands was prepared in 1957. Although these Corps estimates are not part of the PPBS computer record, they provide a starting point for analyzing the 1971 study prepared at the Office of the Chief.

In 1957, the Corps of Engineers estimated that about 109 million acres, or over five percent of the land area of the United States, lies in the flood plain of rivers and streams. Corps flood control work completed or planned for completion at that time would provide flood protection to about 49 million acres of rural lands, with almost half of the protected rural area lying in the alluvial valley of the Mississippi River.[1] Table 9 shows the agricultural and drainage status of rural lands for the entire United States which are protected and planned for protection from floods by the Corps.

The 1957 estimates have been revised as of December 31, 1971. By comparing these revised estimates, as shown on Table 10, with the 1957 estimates (Table 10), some general appraisals can be made of the types of land that have received flood protection or will receive protection by projects now under construction in the 1970's. As of December 1971, Corps of Engineers projects constructed or under construction will provide flood protection for 29.6 million acres of land cleared and suitable for agriculture and an additional 6.3 million acres of land suitable for agriculture when it is cleared.

In the interim of 14 years, 1957 to 1971, flood protection provided or to be provided to rural lands by projects completed and under construction encompasses an additional 4.6 million acres; the 1957 estimate of 49 million acres had grown to 53.6 million acres by December 1971.

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[1] U.S. Senate, Select Committee on National Water Resources, Floods and Flood Control, Committee Print No. 15. U.S. Government Printing Office, Washington, D.C., 1960.

TABLE 9

AGRICULTURAL AND DRAINAGE STATUS OF RURAL LANDS PROTECTED FROM FLOODS BY CORPS OF ENGINEER PROJECTS, 1957

	Completed or Under Construction	Future Work 1/	Total
Agricultural Status	--------------millions of acres	---------------	
Cleared and suitable for agriculture	27.5	13.5	41.0
Suitable for agriculture when cleared	9.9	6.2	16.1
Not suitable for agriculture	9.6	3.1	12.7
Not classified	2.0	1.4	3.4
Total	49.0	24.2	73.2
Drainage Status			
No drainage problem	19.7	13.7	33.4
Drainage works provided	13.1	6.5	19.6
Drainage required	16.2	4.0	20.2
Total	49.0	24.2	73.2

1/ Includes projects authorized but not started and future work.

Source: U.S. Senate, Select Committee on National Water Resources, Floods and Flood Control, Committee Print No. 15.

TABLE 10

AGRICULTURAL AND DRAINAGE STATUS OF LANDS PROTECTED FROM FLOODS BY CORPS OF ENGINEERS PROJECTS AS OF DECEMBER 1971

	Completed or Under Construction	Future Work 1/	Total
	-------------	millions of acres	-------------
Agricultural Status			
Cleared and suitable for agriculture	29.6	19.6	49.2
Suitable for agriculture when cleared	6.3	6.4	12.7
Not suitable for agriculture	8.1	4.3	12.4
Not classified	9.6	6.4	16.0
Total	53.6	36.7	90.3
Drainage Status			
No drainage problem	23.7	11.5	35.2
Drainage works provided	12.7	11.1	23.8
Drainage required	17.2	14.1	31.3
Total	53.6	36.7	90.3

1/ Includes projects authorized but not started and future work.

Source: U.S. Army, Office of Chief of Engineers, Policy Programs and Legislative Branch, Policy and Analysis Division, Washington, D.C., communication of February 15, 1972, to National Water Commission. Estimate from PPBS Computer Record.

Of the additional 4.6 million acres provided or to be provided flood protection, 2.1 million acres consists of land cleared and suitable for agriculture. In addition, as of December 1971, authorized projects not yet started, together with projects planned for the future, would provide flood protection for an additional 19.6 million acres of land cleared and suitable for agriculture, as well as 6.4 million acres suitable for agriculture when cleared.

In 1957, Corps of Engineer projects, complete or under construction and future works, would provide flood protection to an estimated 57.1 million acres of cleared and uncleared land suitable for agriculture. In 1971, the acreage of land in these categories already provided and projected to receive flood protection had increased to 61.9 million acres.

In the 1971 status, in all of the flood plain lands protected or envisaged as receiving protection from future projects, drainage was not required on 35.2 million acres, and on 23.8 million acres drainage had already been provided.

Flood Protection Capability

Estimates prepared by the Corps of Engineers in 1972 delineating by Corps districts the potential flood protection capability of Corps flood control projects are shown on Table 11. Both authorized and unauthorized projects have been examined and broken down into urban and rural land use categories. The extent of rural lands to be protected by these future projects is further broken down into agriculture, woodland, and other non-agricultural, non-urban uses.

In September 1975, the Corps published estimates on the extent of rural flood protection provided by their planned projects for both authorized and unauthorized projects. The data are summarized in Table 12 by Water Resource Region. The rural areas protected and land use of protected areas by project is recorded in the PPBS computer record. In all, 184 Corps projects are planned to reduce damages due to flooding and improve drainage on rural lands. For the nation as a whole, these projects are designed to reduce damages on about 4,500,000 acres of rural lands. More than half (2,268,000 acres) of the rural lands to benefit from these flood control projects are in three water resource regions: the Arkansas-White-Red, 938,000 acres; the Texas-Gulf, 861,000 acres; and the Ohio, 487,000 acres.

Nine land use classifications are identified. Four of these relate to high-value crops, including vegetables and fruits, grain, cotton and tobacco and others. Three land use classes identify low-value crops: roughage, pasture, and other low-value uses. The remaining two uses are timber and non-crop agriculture.

TABLE 11

POTENTIAL FLOOD PROTECTION CAPABILITY:
CORPS OF ENGINEERS FLOOD CONTROL PROJECTS -- 1972

Region/Division/District	Protection Capabilities-Acreage[1/] Authorized Projects Urban	Authorized Projects Rural	Unauthorized Projects Urban	Unauthorized Projects Rural
	(1000)			
New England Region	(10.30)	(10.00)	(0)	(0)
New England Division	10.30	10.00	0	0
Middle Atlantic Region	(21.97)	(33.10)	(91.74)	(44.32)
North Atlantic Division				
Baltimore District	6.20	13.60	30.10	27.20
New York District	6.17	0	50.86	0
Norfolk District	.50	.80	4.00	14.00
Philadelphia District	9.10	18.70	6.78	3.12
South Atlantic-Gulf Region	(12.62)	(925.91)	(15.67)	(422.21)
South Atlantic Division				
Charleston District	1.20	7.50	.90	14.80
Jacksonville District	5.50	9.50	0	0
Mobile District	1.92	63.21	6.67	116.99
Savannah District	0	3.00	1.00	4.60
Wilmington District	4.00	842.70	7.10	286.02
Ohio Region	(101.04)	(567.20)	(46.02)	(317.03)
Ohio River Division				
Huntington District	21.70	192.70	24.70	62.00
Louisville District	42.29	328.40	10.50	223.70
Nashville District	0	0	0	6.00
Pittsburgh District	37.05	46.10	10.82	25.33
Grand Lakes Region	(99.80)	(1.40)	(21.31)	(4.90)
North Central Division				
Buffalo District	8.00	1.40	15.76	4.90
Chicago District	0	0	2.80	0
Detroit District	91.80	0	2.75	0
Upper Mississippi Region	(13.73)	(747.24)	(16.49)	(78.60)
North Central Division				
Rock Island District	6.38	5.20	12.09	55.50
Chicago District	.10	37.13	0	0
St. Paul District	6.70	409.00	4.40	23.10
Lower Miss. Valley Division				
St. Louis District	.55	295.91	0	0
Souris-Red-Rainy Region	(6.70)	(409.00)	(7.80)	(948.30)
North Central Division				
St. Paul District	6.70	409.00	7.80	948.30
Missouri Region	(43.70)	(418.30)	(7.00)	(28.10)
Missouri River Division				
Kansas City District	19.40	319.60	.30	6.40
Omaha District	24.30	98.70	6.70	21.70
Arkansas-White-Red Region	(8.40)	(873.60)	(10.57)	(1146.20)
Lower Mississippi Valley Div.				
New Orleans District	0	82.90	1.62	29.00
Southwestern Division				
Albuquerque District	6.70	11.70	6.85	73.10
Little Rock District	0	263.00	.10	771.10
Tulsa District	1.70	516.00	2.00	273.00
Lower Mississippi Region	(1.40)	(313.99)	(18.84)	(959.19)
Lower Mississippi Valley Div.				
Memphis District	0	62.99	12.85	200.89
New Orleans District	1.40	125.00	5.70	2.00
Vicksburg District	0	126.00	.29	756.30
Rio Grande Region	(7.80)	(0)	(0)	(0)
Southwestern Division				
Albuquerque District	7.80	0	0	0
Texas Gulf Region	(35.90)	(1475.30)	(70.87)	(1313.10)
Southwestern Division				
Ft. Worth District	28.70	1475.30	30.87	1280.10
Galveston District	7.20	0	40.00	33.00
Colorado Region	(11.68)	(38.31)	(59.24)	(16.50)
South Pacific Division				
Los Angeles District	11.68	38.31	58.24	16.20
Sacramento District	0	0	1.00	.30
Great Basin Region	(13.30)	(210.00)	(11.00)	(0)
South Pacific Division				
Sacramento District	13.30	210.00	11.00	0
California Region	(63.96)	(462.69)	(314.66)	(419.20)
South Pacific Division				
Los Angeles District	26.50	1.17	251.27	72.50
Sacramento District	25.30	414.00	43.40	259.70
San Francisco District	12.16	47.52	19.99	87.00
Columbia-North Pacific Region	(7.49)	(202.18)	(34.32)	(356.04)
North Pacific Division				
Portland District	2.10	131.96	12.95	131.55
Seattle District	2.51	39.65	20.87	131.19
Walla Walla District	2.88	30.57	.50	93.30
Alaska Region	(12.00)	(60.40)	(2.00)	(7.60)
North Pacific Division				
Alaska District	12.00	60.40	2.00	7.60
Hawaii Region	(.47)	(0)	(0)	(0)
Pacific Ocean Division	.47	0	0	0
Puerto Rico & Virgin Islands Region	(1.90)	(4.60)	(.94)	(5.60)
South Atlantic Division				
Jacksonville District	1.90	4.60	.94	5.60
THE NATION	474.16	6735.22	728.47	6066.89

1/ Acreage should be interpreted as acres protected from flooding associated with a major flood of approximately 100-year event or greater.

SOURCE: U.S. Army, Office of Chief of Engineers, Policy Programs and Legislature Branch, Policy and Analysis Division, Washington, D.C. Communication of February 15, 1972, to National Water Commission. Estimate from PPBS Computer Bank.

TABLE 12

POTENTIAL USE OF RURAL LANDS PROTECTED BY CORPS OF ENGINEERS
PLANNED FLOOD CONTROL PROJECTS AS OF SEPTEMBER 30, 1975, BY WATER RESOURCE REGION

Water Resource Region	Existing Rural Development Areas Protected From Floods	Projected Land Use of Protected Area 1/: Vegetables and Fruits for Food	Grain	Cotton, Tobacco and Fibers	Other High Value Land Use	Roughage	Pasture	Other Low Value Land Use	Timber	Non-Crop Agriculture	Total Projected Land Use	Total Number of Projects: With Rural Flood Control	With Land Use Details
	(thousand acres)												
Middle Atlantic	29.00	5.38	3.69	0.06	0.40	2.61	3.12	0.12	3.11	1.42	19.91	15	3
South Atlantic Gulf	315.56	4.86	9.45	1.63	1.83	2.44	12.76	0.00	59.37	2.82	95.16	13	10
Ohio	487.01	5.48	124.56	6.70	67.43	36.37	59.29	1.54	70.60	19.95	391.92	24	21
Upper Mississippi	276.93	0.00	146.64	0.00	16.76	4.47	0.42	54.85	1.31	31.66	256.11	27	26
Lower Mississippi	353.31	56.32	82.86	39.01	79.40	0.00	19.89	3.63	47.81	13.20	342.13	13	8
Souris-Red-Rainy	220.50	16.32	126.72	0.00	0.00	0.00	23.66	25.72	20.50	7.57	220.49	2	2
Missouri	281.30	0.00	208.41	0.00	1.32	0.00	11.72	9.93	0.00	34.40	265.78	12	10
Arkansas-White-Red	938.15	21.94	118.08	12.47	128.94	60.81	278.04	17.15	136.82	1.92	776.17	31	28
Texas Gulf	861.00	0.00	132.04	72.18	2.19	74.06	553.82	0.00	4.46	4.04	842.79	11	10
Rio Grande	26.10	1.89	14.80	2.98	1.43	1.10	3.58	0.34	0.00	0.00	26.12	4	3
Colorado	40.66	0.55	5.50	5.50	0.55	0.00	3.33	0.00	0.00	0.00	15.43	4	2
Great Basin	191.00	0.00	0.00	0.00	0.00	28.65	152.80	0.00	0.00	9.55	191.00	1	1
Columbia-North Pacific	158.70	22.54	7.17	0.00	4.65	24.03	44.72	1.21	5.30	0.45	110.07	18	14
California	489.74	29.75	16.14	30.03	23.04	48.30	60.49	0.00	1.46	14.53	223.74	9	7
Total	4,477.96	165.03	913.50	170.59	328.82	202.50	1,227.94	114.86	353.12	141.67	3,776.82	184	145

1/ The total of projected agricultural land use categories does not equal 100 percent of area protected; the difference is accounted for by land areas in rural communities and other non-agricultural use within the rural areas protected. As shown, agricultural land use breakdowns are not available for all projects.

Source: U.S. Department of the Army, Office of Chief of Engineers, Washington, D.C., Computer printout from Planned Programming Budgeting System data bank, September 30, 1975.

The projected land uses in these nine categories were developed from investigations made on 145 projects out of a total of 184 planned projects. This available land use breakdown is indicated for about 3,777,000 acres out of an estimated total land area of 4,500,000 acres. Of the 3,777,000 acres, 1,578,000 is projected to be used for high-value crops. Grain crops are expected to be grown on most of this acreage (913,000 acres). About 1,228,000 acres is projected to be in pasture, with 353,000 acres in timber.

Physical Dimensions of Corps Projects

Rural acres affected by Corps of Engineer projects have been recorded by the Corps and placed into the PPBS computer file. This information shows for each project the degree of rural benefits and project physical facilities. The information is tabulated in Table 13, which shows the physical dimensions of Corps projects showing rural benefits for both completed projects and those under construction.

This information does not specify the extent of rural lands protected from floods, the agricultural use pattern, the land use capabilities, the soil classes, or drainage conditions. Consequently, it is not possible from either the planned project computer file or the completed and under-construction project computer file, presently kept in the Office of the Chief, to make an assessment of how much Corps of Engineer projects do or could contribute to the cropland base of the nation.

TOTAL FLOOD PLAIN LANDS

The proportion of flood plain land differs greatly by river basin and region. Corps of Engineer estimates of flood plain acreage in the various Water Resource Regions are shown in Tables 14 and 15 (in neither case does the Corps include the Tennessee Water Resource Region).

In Table 14, the areas of both flood plain land and total land area in each region are summarized. From this information the percentage of flood plain in each region can be seen. It is interesting to note that almost all of the Lower Mississippi Region, or 93.4 percent, is in flood plains. The next closest region in percentage of flood plain lands is the Ohio Region, with 8.6 percent of total land area in flood plains.

The second set of estimates on total flood plain areas, as shown in Table 16, has flood plain lands measured in acres, while including subtotals for urban and rural areas in flood plains. (Note that the data in Tables 15 and 16 are

TABLE 13

DEGREE OF RURAL BENEFITS FOR CORPS OF ENGINEERS PROJECTS
COMPLETED AND UNDER CONSTRUCTION
30 SEPTEMBER 1975, BY CORPS DISTRICT

Corps District	No. of Projects	Degree of Rural Benefits[1]	Drainage Area (sq. mi.)	Channel Improvements (miles)	Levees (miles)	Flood Wall (miles)
Projects Completed:						
New Orleans	14	9D, 2F, 3H	5,704	142.5	108.3	0
St. Louis	25	23B, 2D	. 982	0	326.6	0
Kansas City	2	2H	223	0	0	0
Buffalo	1	H	1,077	0	0	0
Chicago	21	16B, 5D	61	9.5	137.5	0
Rock Island	20	12B, 4D, 4H	3,084	77.1	380.9	0
Portland	40	34D, 3F, 3H	0	7.9	187.3	0
Seattle	3	3B	74	32.0	0	0
Louisville	19	6B, 6D, 2F, 5H	5,247	70.6	117.4	.3
Los Angeles	5	B, 4D	62,422	0	1.2	0
Sacramento	21	5B, 13D, 3H	34,767	75.2	677.7	1.0
Albuquerque	3	H, D, F	22,148	0	127.4	0
Fort Worth	13	B, 7D, 5F	32,900	0	0	0
Little Rock	25	16B, 9D	3,302	2.1	101.9	0
Tulsa	22	2B, 11D, 8F, H	147,290	19.6	0	0
Total for Completed Projects	234	85B, 105D, 21F, 23H	319,281	436.5	2,166.2	13
Projects Under Construction:						
New Orleans	1	F	1,150	11.6	5.7	0
St. Louis	4	F, 3H	6,983	0	0	0
Vicksburg	1	F	453	0	0	0
Kansas City	8	6B, H, D	15,872	93.0	48.7	0
Norfolk	1	H	344	0	0	0
Rock Island	1	H	314	0	0	0
Portland	2	2F	0	0	0	0
Louisville	10	5B, F, 4H	1,922	67.3	64.9	0
Los Angeles	2	D, H	393	0	0	0
Sacramento	8	2B, 3D, 3H	93,711	160.3	576.2	0
San Francisco	2	D, F	140	9.8	0	0
Fort Worth	3	B, 2D	1,725	2.5	3.8	0
Tulsa	10	3F, 7D	6,764	0	0	0
Total for Projects Under Construction	53	14B, 15D, 10F, 14H	129,771	344.5	699.3	0
Total for Projects Completed and Under Construction	287	99B, 120D, 31F, 37H	449,052	781.0	2,865.5	1.3

[1] Degree of Rural Benefits: B= rural benefits equal 100 percent; D= rural benefits predominate with urban benefits negligible; F= rural benefits exceed 75 percent; H= rural benefits exceed 50 percent

SOURCE: Department of the Army. Corps of Engineers. Office of Chief of Engineers. Washington, D.C., Tabulated October 3, 1975.

TABLE 14

FLOOD PLAIN LANDS IN WATER RESOURCES REGION[1/]

Region	Total Area of Flood Plain (Square Miles)	Total Area of Region (Square Miles)	Regional Land in Flood Plain (Percent)
New England	2,103	62,000	3.4
Middle Atlantic	6,063[2/]	110,000	5.5
South Atlantic Gulf	21,060	276,000	7.6
Ohio	14,063[2/]	163,000	8.6
Great Lakes	4,243	175,000	2.4
Upper Mississippi	16,065	189,300	8.5
Souris-Red-Rainy	2,821	59,000	4.8
Missouri	22,310	515,000	4.3
Arkansas White-Red	15,600	282,000	5.5
Lower Mississippi	55,640	59,600	93.4
Rio Grande	201	136,000	0.1
Texas-Gulf	15,117	182,400	8.3
Colorado	889	247,500	0.4
Great Basin	780	137,000	0.6
California	4,786	164,700	2.9
Columbia North Pacific	6,094[2/]	274,400	2.1
Alaska	12,480	586,400	2.2
Hawaii	41	6,401	0.6
Puerto Rico and Virgin Islands	390[2/]	3,500	1.1
TOTAL	200,746	3,629,201	5.5

1/ Source: Needs Analyses for 1985, Table B-7, titled "Flood Control Needs in square miles for 1985". Office of Chief of Engineers, U.S. Army Corps of Engineers, Washington, D.C. Mimeographed 1973.

2/ Source: U.S. Army Corps of Engineers, Internal Summary 1973, as reported in Table 2, entitled "Total Flood Plain Acres and Urban Acres in Flood Plain," Thomas Maddock, Jr., "Background Summary of Basic Information", in National Conference on Flood Plain Management, page 8. Proceedings edited by Kenneth J. Sabol, Wildlife Management Institute. The relevant areas for the Tennessee Water Resource Region were not included in the reference table, also the Upper and Lower Colorado Water Resource Regions were combined to give the acres for the Colorado Region as shown.

TABLE 15

TOTAL FLOOD PLAIN AREAS: URBAN AND RURAL AREAS IN
FLOOD PLAINS BY WATER RESOURCE REGION
CORPS OF ENGINEERS ESTIMATE 1973

	Total Flood Plain (1000 Acres)	Urban Areas in Flood Plain (1000 Acres)	Rural Areas in Flood Plain (1000 Acres)
New England	1,350	223	1,127
Middle Atlantic	3,880	556	3,324
South Atlantic Gulf	13,500	398	13,102
Ohio	9,000	700	8,300
Great Lakes	2,720	214	2,506
Upper Mississippi	10,300	64	10,236
Souris Red-Rainy	1,810	12	1,798
Missouri	14,300	148	14,152
Arkansas-White-Red	10,500	77	10,423
Lower Mississippi	35,660	130	35,530
Rio Grande	130	21	109
Texas-Gulf	9,560	162	9,398
Colorado	570	113	457
Great Basin	500	59	441
California	3,070	354	2,716
Columbia-North Pacific	3,900	65	3,835
Alaska	8,000	5	7,995
Hawaii	140	21	119
Puerto Rico and Virgin Islands	250	50	200
TOTALS	129,140	3,372	125,768
	201,780 square miles	5,269 square miles	196,511 square miles

Source: U.S. Army Corps of Engineers, Internal Summary 1973, as reported by Thomas Maddock, Jr., in a paper entitled "Background Summary of Basic Information," National Conference on Flood Plain Management, July 24-25, 1974, Statler Hilton Hotel, Washington, D.C.. Proceedings edited by Kenneth J. Sabol, Wildlife Management Institute, Table 2, page 8. In the Table presented by Maddock data are not distinguished for the Tennessee Water Resource Region. The upper and lower Colorado Regions are not shown separately nor are the areas of rural lands. Urban areas were subtracted from total areas to obtain the respective rural areas.

TABLE 16

INVENTORY OF WATERSHEDS FOR WHICH PROJECT DEVELOPMENT IS POTENTIALLY FEASIBLE AND THE KIND AND EXTENT OF PROBLEMS NEEDING PROJECT ACTION, BY STATE

[Because of rounding, some totals may not equal the sum of the items listed. ---indicates less than 500 acres]

State	Watersheds for which project development potentially feasible		Kind and extent of problem—										
			Flood prevention			Agricultural water management			Nonagricultural water management				
			Floodwater and sediment damage		Erosion damage	Drainage	Irrigation	Rural water supply	Municipal or industrial water supply	Recreation development	Fish and wildlife development	Water quality	
			Agricultural	Urban									
	Number	1,000 acres	1,000 acres	1,000 acres	1,000 acres	1,000 acres	1,000 acres	Number	Number	Number	Number	Number	
Alabama	299	15,823	1,462	34	569	453	37	80	70	212	222	143	
Arizona	126	16,222	741	163	1,379	53	408	51	47	84	108	46	
Arkansas	255	19,842	7,877	72	36	5,123	241	20	69	97	151	17	
California	226	13,334	918	45	401	669	1,252	57	72	155	146	73	
Colorado	164	19,805	672	18	3,075	799	2,342	97	85	140	148	100	
Connecticut	32	915	16	3	---	1	---	0	18	29	28	27	
Delaware	15	1,300	99	10	0	108	0	0	2	5	4	8	
Florida	257	16,894	6,502	548	302	6,524	730	26	36	158	152	89	
Georgia	369	28,885	3,467	71	341	1,941	524	154	156	260	258	227	
Hawaii	28	1,064	14	3	38	9	5	15	6	11	10	10	
Idaho	141	18,183	332	7	1,198	358	1,032	22	38	115	120	93	
Illinois	294	19,500	1,637	39	2,515	2,253	10	51	95	187	169	197	
Indiana	209	13,192	913	7	352	581	3	6	55	72	30	19	
Iowa	473	20,135	1,446	22	3,612	3,534	5	22	45	192	195	156	
Kansas	288	31,116	2,450	9	179	59	5	230	169	263	264	249	
Kentucky	281	14,101	961	21	564	426	16	181	115	217	218	202	
Louisiana	132	12,683	4,307	126	39	4,740	494	37	32	89	79	57	
Maine	58	5,507	33	5	236	67	91	51	44	54	48	58	
Maryland	98	3,720	376	13	8	366	20	11	28	56	50	34	
Massachusetts	63	2,132	77	10	---	5	1	7	32	63	63	49	
Michigan	140	9,018	439	68	8	1,335	139	37	33	89	94	55	
Minnesota	657	41,040	2,641	10	786	5,711	5	24	55	431	539	210	
Mississippi	287	22,030	4,155	18	1,059	920	0	177	103	218	227	123	
Missouri	261	22,755	3,044	5	2,838	1,329	0	99	27	250	249	29	
Montana	240	33,239	189	7	22	174	861	7	45	166	151	83	
Nebraska	211	22,514	1,778	18	1,236	759	7	11	18	138	161	47	
Nevada	67	9,340	1,109	19	3,500	108	388	11	19	62	62	38	
New Hampshire	48	3,815	45	13	4	8	1	43	36	43	41	47	
New Jersey	48	2,841	64	14	6	75	50	24	33	43	43	40	
New Mexico	169	19,390	2,297	136	6,141	69	289	89	69	118	120	104	
New York	87	6,400	199	18	172	390	127	54	50	80	78	73	
North Carolina	307	22,322	2,760	54	90	4,045	---	148	108	202	216	131	
North Dakota	57	8,668	1,086	1	2	706	15	4	5	54	54	7	
Ohio	160	15,555	628	37	310	1,691	16	75	89	134	134	124	
Oklahoma	258	29,050	2,132	14	308	143	2	86	112	172	185	168	
Oregon	227	20,187	407	20	553	359	1,652	129	119	212	223	196	
Pennsylvania	56	3,880	50	10	---	1	0	30	24	47	47	40	
Rhode Island	2	148	1	---	0	0	1	0	2	2	2	2	
South Carolina	192	10,609	1,806	35	62	1,586	26	95	68	140	155	106	
South Dakota	205	23,009	701	1	252	480	199	26	35	125	126	70	
Tennessee	307	12,061	1,123	29	437	489	8	143	92	204	199	142	
Texas	260	31,060	2,288	51	785	1,824	273	129	98	190	203	133	
Utah	116	15,610	739	62	5,062	269	1,124	80	29	99	115	96	
Vermont	19	1,143	22	2	16	8	0	9	2	11	13	11	
Virginia	175	13,109	466	20	38	349	57	90	122	146	138	122	
Washington	148	10,941	502	43	376	387	164	72	64	117	130	112	
West Virginia	83	4,243	74	34	41	12	4	40	37	70	72	67	
Wisconsin	204	18,861	422	22	231	634	---	17	45	179	181	116	
Wyoming	105	17,528	121	3	275	47	744	8	16	36	43	27	
U.S. total[a]	8,904	724,720	65,589	1,988	39,453	51,976	13,368	2,875	2,769	6,237	6,464	4,373	
Puerto Rico	21	1,844	83	8	35	77	46	16	18	19	20	18	
Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	
Total	8,925	726,565	65,672	1,996	39,488	52,053	13,415	2,891	2,787	6,256	6,484	4,391	

[a] Watershed inventory not made in Alaska.

SOURCE: National Inventory of Soil and Water Conservation Needs, 1967, U.S. Department of Agriculture, Statistical Bulletin No. 461, p-202.

independent estimates and therefore do not match.) The breakdowns for urban and rural lands in flood plains show once again the significance of the Lower Mississippi as a site of rural flood plain lands. The 35,530,000 acres constitutes the largest number for any region. The ratio of rural flood plain lands to urban land is also greatest in the Lower Mississippi, where over 99 percent of total flood plain lands are rural.

THE LOWER ALLUVIAL MISSISSIPPI VALLEY: A CASE STUDY

As stated, information available indicates that the Lower **Mississippi** Region is largely classified as rural flood plain lands. What is important to emphasize is the significance of Corps of Engineers projects within this area, and the impacts they have had. This section presents a case study designed to illustrate the implications of Corps flood control programs.

The Southern Mississippi alluvial valley encompasses 24.3 million acres bordering the Mississippi River. Of this total, Arkansas and Louisiana contain 8.9 and 7.3 million acres, respectively. Additional acreage is located in Mississippi (4.9 million acres) and Missouri (2.5 million acres). Tennessee and Kentucky contribute the remaining acreage.[1]

In 1951, projects to protect 5.7 million acres of rural lands in the alluvial valley of the Mississippi River were completed, and projects to protect another 7.2 million acres were under construction.[2] In 1972, the Corps of Engineers in the Lower Mississippi Valley Corps Division alone had authorized projects capable of protecting 397,000 rural acres, while unauthorized projects could protect an additional 988,000 acres.[3] The area encompassed by the division represents most of the total alluvial valley of the Mississippi River.

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1 U.S. Department of Agriculture, Economic Research Service, Land Use Change in the Southern Mississippi Alluvial Valley 1950-1969, Ag. Econ. Report No. 215, Washington D.C.

2 Annual Report of the Chief of Engineers for FY 1951, U.S. Army, Part 1, Vol. 3, U.S. Government Printing Office, Washington, D.C., 1952.

3 These figures were obtained by combining the relevant estimates for the Lower Mississippi Valley division in the Arkansas-White-Red Region and the Lower Mississippi Region. Table 12 provided the pertinent averages for this estimation.

The exact role that flood protection provided by the Corps has played in cropland increases in the Southern Mississippi alluvial valley since 1960 is difficult to assess. It must, however, be counted as the fundamental controlling factor in cropland development in this region.[4]

Some indication of the land use changes that have occurred can be discerned from a study of the period 1950 to 1969.[5] In this period, the Southern Mississippi alluvial valley gained 37 percent more cropland. Areas totalling 4.1 million acres were cleared. Unprotected land between the levee and the Mississippi River and its tributaries make up 1.8 million acres, or seven or eight percent of the total area. Cropland use in 1969 represented one-fourth of the unprotected area; cropland occupied 57 percent of the area protected from floods.

The acreage of forest land in the Southern Mississippi alluvial valley with soils suitable for field crops and with problems (principally damaging overflows and poor drainage) that can be remedied and made manageable had been assessed at 5.2 million acres in 1967. This was the potential acreage of new cropland at that time in the Southern Mississippi alluvial valley. No statistics are readily available to show how much of this potential has been utilized from that time to the present or how much, if any, could be directly attributed to Corps flood control projects.

Doubtless, for much of this low-lying fertile land to reach full productive potential would require some form of drainage. Yet much of it would also require clearing. In 1955, Wooten and Jones estimated that 20 million acres of farmland could be developed through drainage. Of this total, seven million acres was in the three delta states of Arkansas, Louisiana and Mississippi, with a major share lying in the flood plain.[6] The drainage problem in the United States is not confined to the flood plains of rivers. An intimate

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4 A definitive study of the impact of the Corps flood protection program entails the identification of land use changes that have accompanied the provision of flood control or the improvement in flood control and drainage for each Corps project. The acreage in cropland and pasture is obtainable from the Census of Agriculture for the census years in counties in the region. Where a county is wholly within the flood plain, identifying the change applicable to flood protection would pose little difficulty. Such a situation would apply generally to the Lower Mississippi Valley; in other water resource regions painstaking and time-consuming effort would be required to apportion to the flood plain itself cropland in counties that overlap the flood plain area.

5 U.S. Department of Agriculture, Economic Research Service, Land Use Change in the Southern Mississippi Alluvial Valley, 1950-1969, Ag. Econ. Report No. 215, Washington D.C.

6 Wooten, Hugh H., and Jones, Lewis H., "The History of Our Drainage Enterprises," U.S. Department of Agriculture Yearbook (Water, 1955), pp. 478, 491.

relationship exists between the needs for flood control and drainage on much of the flood plain. Although a census has not been made of crops grown on land improved by drainage or of the land that, if drained, might be brought into productive cropland in this region, drained agricultural land would presumably be cultivated to corn and soybeans.[7]

The lower alluvial valley of the Mississippi River has been used to show the type of information available on agricultural use and to show the status of flooding and drainage conditions on flood plains where Corps projects have provided varying degrees of protection. The statistics available are admittedly unrefined. They do not allow an assessment of the incremental amount of crop and pasture production that has stemmed from the Corps' flood control and drainage projects.

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7 It has been estimated that "at least 80 percent of the drained agricultural land is used for harvested crops." The principal crops grown on drained lands in 1960 were corn and soybeans in the Corn Belt. (No later figures are available.) In the extensive drained land of Southern Michigan and Minnesota, forages were the dominant crops grown. Vegetable and fruit crops are grown in large areas of drained lands in southern Florida, the Gulf Coast of Louisiana and in the Rio Grande Valley of Texas. In California, where drainage complements irrigation, field crops, including cotton and highly valued fruit and vegetable crops, are grown.

Major Uses of Land and Water in the United States, with special reference to the Agricultural Summary, 1964, U.S. Department of Agriculture, Economic Research Service, Agricultural Economic Report No. 149, November 1968.

CHAPTER VI

FLOOD PLAIN DATA SOURCES OTHER THAN THE CORPS OF ENGINEERS

Data on flood plain lands are available from a number of sources other than the U.S. Army Corps of Engineers. This chapter examines in some detail four of the major sources and reviews both the format and content of the available data. The four sources are the National Inventory of Soil and Water Conservation Needs (CNI), the Flooding Technical Committee Draft Report, the comprehensive framework studies, and flood insurance studies. Of the sources to be examined, both the inventory and the framework studies were prepared by the Department of Agriculture. The Flooding Technical Committee Report was submitted to the National Priorities Committee of the Water Resources Council for use in the 1975 National Water Assessment, while the flood insurance studies are prepared by the Federal Insurance Administration of the Department of Housing and Urban Development.

THE NATIONAL INVENTORY OF SOIL AND WATER CONSERVATION NEEDS

The 1967 CNI was designed to examine the various uses of rural lands and to show selectively the conservation treatments needed. The information is available by states and is subdivided by land capability class and subclass. The inventory also examines small watersheds and delineates the nature and extent of problems needing action.

The state and national averages reported were compiled from county inventories. The county data were collected through field inspections of approximated stratified random sample areas. A two percent sampling rate was generally used, although, because of the differences in the size of counties, the nationwide rate ranged from less than one percent to eight percent. The data on watershed projects were collected through field studies of river basins, resource conservation and development projects, and the process of updating land use and treatment needs. The original data from the CNI on land use, land capability, and flood prone lands were collected between 1957 and 1961.

Estimates of total flood-prone lands for the United States for which project development is judged to be potentially feasible and the types and extent of the problems requiring project action are shown in Table 17. The agricultural

TABLE 17

CROPLAND IN TILLAGE ROTATION
NEEDING DRAINAGE TREATMENT BY STATE[1/]

State	Acres	State	Acres
Alabama	180,021	Nebraska	582,135
Alaska	722	Nevada	0
Arizona	0	New Hampshire	17,613
Arkansas	3,022,387	New Jersey	83,455
California	84,542	New Mexico	90
Colorado	0	New York	952,425
Connecticut	25,234	North Carolina	991,780
Delaware	135,676	North Dakota	1,432,727
Florida	69,507	Ohio	4,794,523
Georgia	328,752	Oklahoma	169,191
Hawaii	0	Oregon	497,236
Idaho	116,639	Pennsylvania	401,114
Illinois	3,156,697	Rhode Island	2,511
Indiana	3,515,731	South Carolina	579,715
Iowa	3,596,778	South Dakota	466,148
Kansas	327,216	Tennessee	374,116
Kentucky	507,938	Texas	875,716
Louisiana	1,360,523	Utah	969
Maine	184,820	Vermont	135,516
Maryland	247,816	Virginia	411,402
Massachusetts	22,525	Washington	277,511
Michigan	1,531,370	West Virginia	48,043
Minnesota	6,257,995	Wisconsin	1,224,013
Mississippi	1,645,539	Wyoming	200
Missouri	2,228,948	Puerto Rico	45,802
Montana	139,084	Virgin Island	51
		TOTAL	43,005,000

1/ Includes Carribean area

Source: National Inventory of Soil and Water Conservation Needs 1967. U. S. Department of Agriculture, Soil Conservation Service Statistical Bulletin No. 461, Washington, D.C., January 1971. Various tables.

land areas subject to floodwater and sediment damages where corrective action is considered feasibly justified are shown by states and the total is about 65,500,000 acres (excluding Alaska).[1] The area is approximately two-thirds of the total area (93,000,000 acres) considered to require remedial measures.[2] The problems and the areal extent where project developments may provide solutions to problems of drainage, erosion damage, irrigation, and the like are also shown.

The 1967 CNI does not provide a summary of land use in the flood plains, nor does it indicate the extent of agricultural production problems stemming from flooding or poor drainage conditions in flood plains. For the class of problems that might be remedied by better agricultural water management, it was estimated that improved drainage is required on some 52 million acres. Although it might be assumed that flood plain lands would be involved in a major way, the extent of the drainage problem and the acreage involved are not identified for flood plains as such.

For non-irrigated cropland in tillage rotation, the CNI indicated that improved drainage is required as a conservation treatment (for optimum crop yield) on some 43 million acres, as shown in Table 16. An estimated 37 million acres of the 43 million acres requiring improved drainage is made up of soils in Land Capability Classes IIw and IIIw, where excess water resulting from poor soil drainage, wetness, highwater table and overflow is the principal limitation.

The reliability of the CNI data in determining the composition of soils in flood plain lands has been studied.[3] It was found that the agreement between CNI data and soil survey data becomes progressively better as the area sampled by the national inventory increases in size. The national inventory could be used safely as a source of flood plain land classification only for flood control projects having impact areas exceeding 200,000 acres. Thus, though no implications were drawn in this study on reliability of the CNI in assessing the actual size of flood plain crops, the following inference might be made: For the larger sampled area in the flood plain, the areas of "floodwater and sediment damage" approximate more nearly the natural flood plain area.

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1 Agricultural lands include nonfederal croplands, grasslands and forest lands.

2 National Inventory of Soil and Water Conservation Needs, 1967, USDA Statistical Bulletin No. 461, page 3.

3 Thomas Maddock, Jr., "Background Summary of Basic Information," National Conference on Flood plain Management, July 24-25, Statler Hilton Hotel, Washington, D.C., edited by Kenneth J. Sobol.

THE DRAFT REPORT OF THE FLOODING TECHNICAL COMMITTEE

Upstream flood plain lands have recently been prepared for the U.S. Water Resources Council by the Flooding Technical Committee. In Table 18, the flood plains are delineated as upstream areas inundated by a 100-year flood for each of the water resource regions. Over half of the total area inundated is designated as agricultural cropland.

THE COMPREHENSIVE FRAMEWORK STUDIES

River basin surveys have been prepared under the Department of Agriculture in cooperation with other federal, state, and local agencies. The surveys are designated as framework, regional or river basin plans, implementation studies, or cooperative studies. The framework and regional studies are of particular importance in regard to flood plains, and they will be discussed further.

For the comprehensive framework studies, the nation is divided into 20 water resource regions. Seventeen regions cover the continental United States; the other three cover Alaska, Hawaii, and Puerto Rico. Only 12 of the framework studies have been completed for regions within the continental United States. Framework studies will not be prepared for the following five water resource regions located within the continental United States: Rio Grande; Arkansas - White-Red; Texas Gulf; Tennessee; and South Atlantic-Gulf Regions. For completed studies, data on flood plain lands are generally contained within the appendix on flood control, although in some cases information is located in other appendices. The presentation format and the data included differ for virtually every region.

Some information is available from the comprehensive river basin framework studies that have been completed. The information, however, is far from comprehensive. Out of 20 Water Resource Regions, areas in flood plains have been distinguished by their upstream and downstream locations for only four regions -- Ohio, Upper Mississippi, Lower Mississippi and Missouri. The classification into urban and rural lands in the total flood plain has been undertaken for only three water resource regions -- North Atlantic (which combines New England and the Middle Atlantic), Great Lakes and the Souris-Red-Rainy Region. A division of the rural land in flood plains into cropland and pasture acres is available for only two regions -- North Atlantic and Souris-Red-Rainy.

TABLE 18

UPSTREAM FLOOD PLAINS - URBAN AND RURAL AREAS

1975

Water Resources Council Region	Upstream Area Inundated by 100-year Flood (a) Urban and Built-up (1000 acres)	(b) Agricultural Cropland (1000 acres)	(c) Other (1000 acres)	Rural d = b + c (1000 acres)	Total (1000 acres)
New England	51	169	767	936	987
Middle Atlantic	148	1,980	2,985	4,965	5,113
South Atlantic Gulf	508	8,266	22,347	30,613	31,121
Great Lakes	66	781	2,403	3,184	3,250
Ohio	117	2,199	904	3,103	3,220
Tennessee	19	762	159	921	940
Upper Mississippi	95	4,150	1,020	5,170	5,265
Lower Mississippi	118	18,559	1,858	20,417	20,535
Souris Red-Rainy	5	1,275	309	1,584	1,589
Missouri	53	7,106	1,098	8,204	8,257
Arkansas-White-Red	124	7,212	2,958	10,170	10,294
Texas Gulf	75	1,110	3,274	4,384	4,459
Rio Grande	124	832	4,214	5,046	5,170
Upper Colorado	12	348	173	521	533
Lower Colorado	164	1,148	4,246	5,394	5,558
Great Basin	5	41	96	137	142
Columbia - North Pacific	117	1,647	544	2,191	2,308
California	38	900	314	1,214	1,252
Alaska	67	4	2,683	2,687	2,754
Hawaii	20	21	-	21	41
Caribbean	22	86	67	153	175
United States and Caribbean Area	1,948	58,596	52,419	111,015	112,963

Source: Draft report of the Flooding Technical Committee submitted to National Priorities and Assessment Committee of the U. S. Water Resources Council, Soil Conservation Service, United States Department of Agriculture, Washington, D. C., September 19, 1975.

The following describes the available information on flood plain lands as contained in the framework studies:

Region	Geographic Division of Data	Subcategories of Data Reported
North Atlantic	Subregion and area	Land use, watershed area
Great Lakes	State	Urban/rural
Ohio	River basin	Downstream/upstream
Upper Mississippi	Plain area	Downstream/upstream
Lower Mississippi	Water resource area (headwater/backwater)	Principal streams/ upstream watersheds
Missouri	Subbasin	Main stream/tributary area
Souris-Red-Rainy	Basin	Land use
Upper Colorado	Subregion and river basin	
Lower Colorado	Subregion, study area, and stream	
Columbia-North Pacific	Subregion	
Great Basin	Subregion, study area, and stream	
California	Subregion, study area, and stream	

The river basin and regional plans vary according to both the presentation format and data included, just as the comprehensive framework studies varied. Each of these plans is confined to a much smaller area, and all of the plans together do not cover the continental United States. As a result, the river basin and regional plans are not effective for examining flood plain lands over a large area.

FLOOD INSURANCE STUDIES

Major floods in the United States have prompted the federal government to join with the insurance industry to provide flood insurance in flood-prone areas. The Federal Insurance Administration (FIA) of the Department of Housing and Urban Development is responsible for administering the program. The work of designating flood hazard areas and flood insurance zones is carried out by private engineering consulting firms or federal agencies, including the Army Corps of Engineers, the Geological Survey, the Bureau of Reclamation, the Soil Conservation Service, the National Oceanic and Atmospheric Administration, and the Tennessee Valley Authority.

Only a small portion of the work of the Flood Insurance Administration has been completed; therefore, only limited data are available from this source. Most of the work will not be completed for a number of years.

CHAPTER VII

APPRAISAL OF AGRICULTURAL FLOOD DAMAGES

INTRODUCTION

Damages from floods and restricted drainage in rural areas have caused a need for protective facilities and, consequently, a need for procedures to evaluate the effects of poor drainage and overbank flooding on agriculture. For the Corps of Engineers and other groups to evaluate the economic feasibility of flood control and drainage projects and programs, these naturally occurring damages must be appraised.

This chapter examines the methods by which the Corps of Engineers evaluates flooding damage to agricultural lands or, alternatively, estimates project benefits. Typically, flood control and drainage project benefits were equivalent to a reduction in damages. The difference between methods currently used and those studied for future use will be discussed along with the different data derived from the methods. Crop damage and agricultural enterprise analyses prepared by the Sacramento and Albuquerque Districts will be presented and discussed to more fully illustrate the actual application of Corps procedures.

Alternative appraisals and discussions of the impacts of drainage and overbank flooding on the agricultural productivity of rural floodplains will be included for illustration and comparison. These alternative appraisals have been prepared by ERS and the Soil Conservation (SCS) of USDA.

It should be noted that there is no one absolutely common method used by the Corps of Engineers to appraise flood damages and benefits. A number of variations have been used and are still being used by the various Corps districts. Yet, there are common procedures and guidelines, and these will be emphasized.

GENERAL FLOOD DAMAGE CONSIDERATIONS

A number of specific damages are caused by flooding. This section outlines the basic causative factors and the damages resulting from the flooding of agricultural lands. It also outlines research and studies outside of Corps sources that indicate the general significance of flood damages to crops.

General Damages and Causative Factors

Flood damages result from three general flood-related factors:

-- Impacts of debris and water
-- Inundation of land and crops
-- Erosion and sedimentation

Specific damages caused by the above would include, but are not limited to the following:

Impacts of Water and Associated Debris

-- Damages to standing crops
-- Damage to equipment and improvements

Inundation of Land and Crops

-- Damage to standing crops
-- Water-logging of soils
-- Transport and introduction of disease
-- Limitation of cropping intensity potential and restriction of subsequent cropping patterns

Erosion and Sedimentation

-- Loss of top soil and natural fertility
-- Loss of agricultural chemicals
-- Damage to standing and planted crops
-- Damage to equipment and improvements
-- Transport and introduction of disease
-- Transport and disposition of harmful agricultural chemicals
-- Limitation of the potential for multiple cropping and restriction of subsequent cropping patterns

The above may include some net or, most probably, partial benefits such as deposition of a fertile topsoil and beneficial soil additives and addition of soil moisture in arid areas.

The damages noted can cover a wide cost range. Crop damage, for example, would range from a slight reduction in yields to the complete destruction of the crop. A very substantial loss in capital investment could occur, e.g. should an orchard be completely destroyed.

It should be noted that other flood-caused damages not directly related to agricultural production and croplands often occur simultaneously and damage public and private property and facilities.

Sample Damage Levels

ERS prepared estimates of crop losses from flooding. In Table 19, annual equivalents for reductions in yield due to flood hazards are shown for the Grand River Basin of Missouri and Iowa. Five major crops of the area are examined in 11 potentially improved areas. The percentage of crop yield loss was found to be greatest for corn and soybeans and least for hay and permanent pasture. For corn and soybeans, crop losses ranged from four to over 40 percent of total yields, while for permanent pasture the loss ranged from only one to 13 percent of total yields.

The percentage of crop production lost from flood damages has also been calculated for the Arkansas-White-Red Water Resource Region. Annual average damage equivalents were determined for selected agricultural land uses under one, two, and three feet of water, and by season. The crop damages from flooding are shown in Table 20.

Tables 19 and 20 indicate yield losses as a function of four of the critical variables -- crop, season of flooding, area of flooding and flood water depth.

TABLE 19

DAMAGE FACTORS BY CROP AND REACH AREA,
GRAND RIVER BASIN, MISSOURI AND IOWA

Area and Reach Number	Crop				
	Corn	Soybeans	Wheat	Hay and Rotation Pasture	Permanent Pasture
	Damage Factor [1]				
Potentially Improved Area:					
1	14.94	14.25	10.67	5.98	4.48
2	41.81	39.56	32.28	16.72	12.54
3	43.27	41.05	26.73	17.31	12.98
4	19.77	6.64	11.60	7.91	5.93
5	17.91	17.70	16.60	7.16	5.37
6	4.16	4.22	2.98	1.66	1.25
7	20.88	22.29	13.55	8.35	6.26
8	32.41	32.49	25.88	12.96	9.72
9	20.04	20.12	16.15	8.02	6.01
10	10.10	10.11	7.96	4.04	3.03
11	21.35	21.77	17.99	8.54	6.41
Acquisition Area:					
Braymer	20.04	20.12	16.15	8.02	6.01
Pattonsburg	19.77	6.64	11.60	7.91	5.93
Trenton	7.00	6.96	5.56	2.80	2.10
Mercer	4.16	4.22	2.98	1.66	1.25
Linneus	20.88	22.29	13.55	8.35	6.26
Brookfield	32.41	32.49	25.88	12.96	9.72
St. Catherine	32.41	32.49	25.88	12.96	9.72

[1] Percentage reduction in yields due to flood hazard; based on Corps of Engineers Net Damage Factors.

Source: Grand River Basin, Missouri and Iowa, Appendix A, Primary Effects on Agriculture of the Proposed Corps of Engineers Water Resource Development, prepared by USDA, ERS, Forest Service and Soil Conservation Service, Table 15.

TABLE 20

CROP DAMAGES FROM FLOODING

(Flood damage factors for Arkansas-White-Red Water Resource Region, 1966 - 1970)

Season	Percentage of Crop Damaged		
	One Foot	Two Feet	Three or More Feet
	Flood Depth		
COTTON			
March - April	48		
May - June	32	40	45
July - August	30	34	
September - October	20	36	35
Multiple Flooding		45	
SOYBEANS			
January - April		22	0
May	29	33	61
June	47	52	53
July - August	47	70	
Other	36	67	32
Multiple Flooding		43	
WHEAT			
January - February			
March - April	25	38	28
May	21	31	37
June - August	29	21	50
September - December	8	11	13
Multiple Flooding		34	
ALFALFA			
April - July	12	9	16
August - October	4	4	5
Other	3		
Multiple Flooding		21	
OTHER HAY			
January - March	14	18	18
April - June		33	
July - October	1	0	6
Multiple Flooding		19	
IMPROVED PASTURE			
January - March	1	7	
April - June	6	8	12
July - October	1	4	2
Multiple Flooding		21	
OPEN NATIVE PASTURE			
January - March	0	2	8
April - September	4	5	6
October - December	1	1	2
Multiple Flooding		17	
TIMBERED PASTURE			
April - September	5	6	9
October - March	0	1	2
Multiple Flooding		17	

SOURCE: Evaluating the Upstream Watershed Protection and Flood Prevention Program, Arkansas-White-Red Water Resource Region, ERS-551, U.S. Department of Agriculture, Economic Research Service, Washington, D.C., April 1974, Appendix.

CORPS OF ENGINEERS DAMAGE APPRAISALS[1]

Basic Considerations

A number of procedures are preliminary to the actual calculation of crop losses due to flooding. Detailed agricultural information has to be obtained on the area of potential flooding. Currently existing cropping patterns and schedules of crop growth need to be prepared to identify the location and extent of the various agricultural land uses and the stages of growth expected for different times of the year. This information must be available for each of the agricultural land uses in the area being examined. Knowing the acres of productive land, the variety of crops grown, and the yields per acre is necessary before flooding costs and flood control benefits can be evaluated.

Cost and revenue information on farm production are also preliminary. Cost estimates must be prepared for all the major aspects of crop production, including land preparation, seeding, and fertilizer and pesticides application. The cost data are available from a number of sources, both primary and secondary. Interviews with individual farmers provide information on a variety of conditions in the area of potential flooding. Farmers can explain their crop distribution, normal yields, timing of planting, harvesting, and other operations, the quantity and types of inputs used, and the individual costs incurred in production. Similarly, county agents, land grant schools, Agricultural Extension Services, and other government officials within the USDA and other state and federal agencies are sources of primary agricultural information, as are many private producers and marketing and commodity groups.

Normalized Market Prices

Market prices for agricultural crops used for the appraisal of flood damage and flood control benefits have traditionally been current prices as provided by local, state, or federal officials. These prices are then adjusted, if necessary, for the specific needs of a project study. At present, price

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1 Acknowledgement is given to Mr. George Zimmerman, an economist with the Southwest Division in Dallas. Information on Corps methods and procedures as contained in the following section, "Corps Flood Damage Appraisal," was in large part provided in a telephone conversation on January 8, 1976.

information is provided by the Water Resources Council.[2] Current normalized prices are prepared on a national level for individual crops, with appropriate relationships indicated for specific crops and states. This allows states to apply prices adjusted to the conditions within the state.

When normalized crop prices are applied to the information on specific crop acreages and yields, it is possible to develop dollar values for the agricultural protection currently existing on a flood plain. This information is the starting point for estimating the crop losses due to flooding.

Specific Crop-Loss Appraisal Method

Calculating the loss in crop value that occurs as a result of a specific flood generally involves using an income method of appraisal. Estimating the specific crop loss that results from an experienced or anticipated event involves the difference between two values. The first is the dollar value of the average or normal crops grown in an area. From this value is subtracted the dollar value of the actual crop grown in the year of the flood, or the estimated value for assumed floods, adjusted for the expended and unexpended costs of production. Specific crop loss can be calculated when replanting is possible or when it is impossible. The equations for calculating specific crop losses are presented for each of the two cases as follows:[3]

When replanting is possible -

Specific crop loss = (Average value of normal crop) - (Actual value of replant crop) - (Unexpended costs of lost crop) + (Rehabilitation costs) + (Expended costs of replant crop)

When replanting is impossible -

Specific crop loss = (Average value of normal crop) - (Unexpended costs of lost crop) + (Rehabilitation costs)

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2 U.S. Water Resources Council, Agricultural Price Standards, for Water and Related Land Resources Planning, Guideline 2, Washington, D.C., October 1974.

3 U.S. Army Corps of Engineers, Office of the Chief, Economic Evaluation of Flood Damages and Flood Control Benefits, EM 1120-2-106, Section VII, Washington, D.C., 1956, p. 87.

The methodology for estimating crop loss does not include all factors causing damage. Direct rainfall damage, for example, is difficult to separate from flood damage; thus, the increased damage resulting from flooding cannot always be isolated. Damages caused by factors other than flooding cannot be considered a benefit of flood control protection. Yet, because of the uniqueness of each situation and the difficulty of quantifying all factors, crop and flood plain soil damage can be attributed to flooding.

Similarly, sheet erosion, hail, and storms in general cause agricultural crop damage. With conditions of drought, some flooding can be a benefit. These factors in crop damage are not directly accounted for in the determination of flood crop losses. Many of these problems in evaluating crop losses are due to inadequacies of or gaps in the available data and the difficulty of quantifying all of the influencing factors. The usefulness and limitations in Corps methods and procedures will be discussed more fully at the end of the following section on anticipated crop damage.

Anticipated Crop Damage Appraisals

Determining the extent of future crop damage is a complicated process. The value of normal and replanted crops must be calculated and adjusted for the different costs, estimates must be projected for crop prices and yields, and the probabilities of flood occurrence and inundation period, flood stage, and flood intensity must be estimated or assumed. A number of methods are available for calculating anticipated crop damage over the range of flood stages. Each of these is best suited to specific conditions as described below: [4]

Stage-Damage and Damage - Frequency Crop Relations -- Stage-damage relations for specific crops can be prepared by taking the crop damages for the time of year under analysis, and applying this to historic stage-area curves showing the land area inundated by each use. The stage-damage relations, when combined with seasonal discharge-frequency and stage-discharge curves, (and specific crop loss estimates) give the estimated average annual crop damages per season, which when totaled and averaged give one estimate of average annual damages.

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4 U.S. Army Corps of Engineers, Office of the Chief, Economic Evaluation of Flood Damages and Flood Control Benefits, EM 1120-2-106, Section VII, Washington, D.C., 1956, p. 100.

Seasonal Composite Acre Method -- A weighted average damage per acre can be computed when land use, crop types and resultant damages are relatively uniform over the range of flood areas and stages. This damage is computed utilizing the composite value arrived at by weighting the damages for each specific crop in proportion to the land area devoted to its use. The composite acre value can then be used with the total stage-area curve in calculating average annual damages.

Annual Composite Acre Method -- When the seasonal differences in the frequencies and size of floods are slight, flood frequency by season can also be applied to individual crop damage appraisals to derive a single weighted average annual damage per acre. The damage per acre can then be applied to estimates of acreage flooded for any event rather than by season.

A limitation can be observed in one of the preceding methods for calculating anticipated crop damage. The seasonal composite acre method has serious limitations when land uses or crop types are not uniform over the range of flood stages. Greater damages may be credited to low lands more often flooded, thus resulting in an overstatement of benefits from flood control.

As with the estimation of experienced crop loss, the calculation of anticipated crop damage is based primarily upon the depth and areal extent of floodwater. Crop damages caused by other factors, such as storm conditions, hail, or even sheet erosion, are not included directly in the analysis. The researcher must include all flood-related factors that cause damage, while excluding factors that cause crop damage for reasons other than flooding. Flood factors responsible for crop damage, and not represented by flood stage, include the duration of flooding, the velocity of flow, the silt load in the floodwaters, and existing groundwater levels. Crop damage is also affected by the stage of plant growth at the time of flood. The examinations of crop damage by season take this factor into account only partially.

The sophistication of analysis will tend to vary in each of the Corps' districts. A factor such as duration of flooding is a case in point. Some districts have included flood duration in their analysis of flood damages to the extent of having duration curves. Other districts include duration, but in a much less quantitative manner. This difference could be significant in the calculation of flood damages. One day of flooding may have no real impact upon a crop, whereas an additional five or six days could be the difference between a good crop and a total loss.

One area in which there is little variation between districts is in benefit evaluation from flooding. These benefits, although perhaps minor, are virtually always excluded from the analysis of flood damages.

There are provisions in the analysis to cover rehabilitation costs. It would be assumed that these could be adequate to cover forgone production costs and repair and rehabilitation of equipment and improvements. Possible increases in diseases and limitations in cropping intensity and subsequent-year cropping are not fully recognized.

The Corps allows adjustment of damages as a function of depth of inundation. Computation of damages strictly on the basis of the area of inundation is also allowed. Although using the variable-depth approach would seem appropriate in most instances, it must be recognized that available damage data do not always justify this refinement.

Albuquerque District Approach

The procedure used by the Albuquerque District[5] to evaluate crop damage includes depth as a variable, as well as growing season and area of inundation. Tables prepared for use in the district show for individual crops the percentage of crop yield reduction for selected flood depths. This information is arranged by month for flood depths ranging from zero to over six feet.

The damage estimates are average figures that reflect reductions in crop yields that have occurred from past floods. After a flood, farmers were surveyed to determine their crop yield losses. This information was detailed for each of the principal agricultural land uses in the district. To evaluate a particular flood event, normalized prices are applied to these average yield reductions to obtain a dollar value of crop losses. This value is then adjusted for other factors having a detrimental impact on crops. Damages to land and improvements are handled separately.

This approach evaluates net production-cost losses in terms of an equivalent yield. In years with extreme market prices for inputs and produce, inequities could result.

5 This section was prepared based on a recent flood study conducted by Development and Resources Corporation for the Albuquerque District, Corps of Engineers.

Sacramento District Approach [6]

Flood Losses -- Flood losses are calculated in a different manner in the Sacramento District than they are in the Albuquerque District. The Sacramento District determines flood losses based upon a separation in agriculture costs and revenues as a result of flooding. Consequently, the analysis is more detailed in this respect. Two expressions of the Corps' standard approach are used to compute the flood loss values. These equations are shown below:

$$\text{Flood Loss} = NR + FC + VC_e$$

$$\text{Flood Loss} = GR - VC_n$$

The variables used are defined as follows:

NR is the net return from individual operations.

GR is the gross return calculated by taking yield per acre multiplied by the price per unit of yield.

VC is the variable cost of production.

FC is the fixed cost of production.

The net return is further defined as: $NR = GR - VC - FC$

VC_e is a subcategory of variable cost. It is the variable cost expended to produce a crop up to the time of flood damage.

VC_n is a subcategory of variable cost representing the nonexpended variable costs of production that would have been necessary to mature and harvest a crop had flood losses not occurred.

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6 This section was prepared from information contained in the files of the Economics Division of the Sacramento District, Sacramento, California. The materials were prepared by Ralph C. Jones in mid-1975. A personal conversation was held with Mr. Jones on January 7, 1976, to supplement the information in the files.

Either of the two flood loss equations is used to calculate flood losses. The choice of equation is primarily determined by the availability of data.

Expected Crop Damage -- The crop damage anticipated as a result of various flood types is calculated by first determining the probability of flooding. The chance that a flood will occur must be computed for each of the months of the year because of the significance of the time of year on crop production. The month in which a flood occurs affects both the value of crop production lost and the time required for drainage and cleanup.

Floods during the winter months may preclude crop production for one season, while a summer flood may preclude crop production for two seasons. An important factor is the type of current land use. Perennial crops, such as orchards, would take much longer for regrowth than annual crops.

Prices, Yields, and Costs -- Agricultural prices used in the calculation of damages are normalized according to the methodology developed by the Water Resources Council, as earlier discussed. Regression analysis is used both to normalize prices and to derive crop yields. Production costs are determined using information provided by the Agricultural Extension Service of the University of California. Costs are determined for the month in which they would occur so that they can be more accurately applied to anticipated floods.

Tables 21 and 22 provide detail about some of the methodology used in the Sacramento District to calculate flood losses. Table 21 shows the calculation of average yields and normalized prices for barley grown in the floodplains of Merced County streams. Table 22 is a computation sheet on the costs of producing alfalfa in the Isleton Project. Included in the loss computation for flooding are cultural and harvest costs and clean up costs. The two tables are only working papers and should not be construed as a final district presentation.

POTENTIAL DAMAGE ASSESSMENT METHODS

Various methodologies have been examined for evaluating flood control benefits. Two studies designed to evaluate agricultural benefits derived from flood control have been prepared by the Institute for Water Resources. They are discussed in this section.

TABLE 21

SAMPLE COMPUTATION SHEET OF COSTS TO PRODUCE ALFALFA HAY
ISLETON PROJECT - SACRAMENTO COUNTY

Variable Costs	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Cultural Costs													
Winterweed Control			9.00	9.00									18.00
Fertilize				16.00									16.00
Insect Control						7.50			7.50				15.00
Irrigation							5.00	5.00	5.00	5.00	5.00		25.00
Ditchweed Control								1.00	1.00	1.00			3.00
Subtotal			9.00	25.00		7.50	5.00	6.00	13.50	6.00	5.00		77.00
Harvest Costs													
Green Chop							22.50	22.50	22.50	22.50	15.00		105.00
Subtotal							22.50	22.50	22.50	22.50	15.00		105.00
Total			9.00	25.00		7.50	27.50	28.50	36.00	28.50	20.00		182.00
Accumulative			9.00	34.00	34.00	41.50	69.00	97.50	133.50	162.00	182.00	182.00	
Loss Computation Due to Flooding													
Gross Return[1]	373	373					746	746	746				
Total Variable Costs	182	182	182				364	364	364				
Expended Variable Costs to Date	0	0	9				69	97.50	133.50				
Variable Costs Not Expended to Date	182	182	173				295.00	266.50	230.50				
Total Loss (GR-Variable Cost Not Expended to Date	191.00	191.00	200.00				451.00	479.50	515.50				
Probability of Flooding[2]	.167	.166	.167	0	0	0	.167	.166	.167	0	0	0	1.00
Total Loss Cleanup	31.90	31.71	33.40				75.32	79.60	86.09				= 338.02
													+ 150
													488

1/ Assume planting by Sept. 30, 4-year life, hand moved sprinkler irrigated. If flooding occurs during May, June, July, two years of production is assumed forgone. If flooding occurs during Nov., Dec., Jan., replanting is possible; thus a crop can be expected the second year.

2/ Tidal flooding is expected.

TABLE 22

SAMPLE COMPUTATION SHEET OF NORMALIZED 1974 PRICES
MERCED COUNTY STREAMS

(All numbers from Report of Agriculture, Merced County)

Year	Peaches/Ton		Barley/Ton		Hay/Ton	
	$/Ton	Ton/Acre	$/Ton	Ton/Acre	$/Ton	Ton/Acre
1964	73	11.3	47	1.2	28	5.3
1965	69	12.0	48	1.25	24	5.35
1966	68	14.0	52	1.5	29	6.25
1967	82	10.5	48	1.25	30	5.30
1968	75	15.0	45	1.0	27	6.0
1969	74	11.3	50	1.5	29	6.0
1970	81	10.3	57	1.5	29	6.0
1971	79	10.5	59	1.5	32	6.0
1972	75	13.0	59	1.25	35	6.0
1973	97	13.0	85	1.20	49	6.0
1974	132	15.3	119	1.25	63	6.0
Average	82	12.4	61	1.31	34	5.84
r =	.706		.763		.777	
m =	3.81		5.12		7.72	
b =	42.82		35.23		20.5	
Normalized Prices	102		86		48	

Land Value Benefit Measurement

A land-value multiple-regression technique was developed by ERS under contract to the Corps of Engineers.[7] The technique is a theoretical means of estimating income changes directly from relative land values, rather than through the use of conventional estimating procedures. The land-value method operates on the principle that land values are affected significantly by flood risks. Differences in land values due to differences in flood risk are used in the estimation of benefits of flood control projects. The land-value multiple regression technique has been applied to the Wabash River Basin and an area of the Missouri River, with similar results.

The study indicated that one benefit of land-value multiple-regression technique is that it allows for the comparison of farms that do not have the same non-flood-hazard characteristics. This is accomplished by weighting each of the non-flood factors to reflect its significance to the value of land. The statistical significance of each factor, such as flood risk, may therefore be tested for its importance and dependability.

In the application of the land-value method, assumptions have been made, including the elevation of the zero damage point related to the projection of rating curves, the effective protection of non-federal levees, and the composite acreage of land use. The accuracy of the model relies upon the ability of the land market to reflect flood hazards, which is not always likely in areas subject only to light or infrequent floods. Also, land values must be adjusted for significant comparison. From the study, it was felt that the land value approach appears to be most appropriate as a check on other methods when a significant level of agricultural crop benefits is anticipated from a project or program. This model could also be helpful in verifying a borderline cost benefit ratio that has been obtained by traditional means.

IWR-ERS Regional Linear Programming Model

An alternative method to the land value approach is available for evaluating agricultural flood control benefits. This method was also prepared by ERS.[8] The model is basically an extension of the regional linear programming (RLP) model currently used by ERS and applied to project analysis. The RLP model

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7 U.S. Army Corps of Engineers, Institute for Water Resources, Agricultural Flood Control Benefits and Land Values, IWR Report 71-3, Alexandria, Virginia, June 1971.

8 U.S. Army Corps of Engineers, Institute for Water Resources, Analysis of Alternative Procedures for the Evaluation of Agricultural Flood Control Benefits, IWR Report 71-4, Alexandria, Virginia, July 1971.

is used to estimate the on-farm costs of production for the estimated amount of production in 1980. These costs are then compared with varying degrees of flood protection.

The RLP model assumes inelastic demand conditions. That is, it is assumed that product demand is not affected by changes in prices, which is considered unrealistic. Another limitation to the use of the model is the lack of quantity and quality information. Specifically, information that is described as needed includes acreage by soil class, crop yields and production costs for present and future conditions, flood hazard information, and the extent of protection made available by flood control projects.

The model is useful, however, in that it makes possible the estimation of the agricultural flood damages under projected future conditions. As concluded by the study, the method takes independent projections of agricultural commodity demands and includes anticipated changes in crop yields in order to calculate future benefits.

DRAINAGE IMPROVEMENT BENEFITS

The evaluation of drainage improvement projects for chronic wetland problems is fundamentally different from the evaluation of flood control projects. Flooding increases the risk of crop damage and limits the choices for the use of otherwise suitable agricultural land. Flood control works decrease the risks to crops and allow more choices in the use of land. Drainage improvements, on the other hand, generally improve the soil resource by eliminating or controlling standing water or excessive soil moisture. Drainage improvements also are distinct in that actual benefits are measured rather than a reduction of flood damage. In some instances flood control and drainage works are inseparable. For example, where improving the surface drainage reduces flood stages and the duration of the flood-water inundation, a drainage improvement project could result in both flood control and drainage benefits.

As a general policy, drainage benefits are measured by the increase in net agricultural revenues. In measuring drainage benefits, normal preproject conditions are compared with the conditions experienced or anticipated after the drainage project is constructed. Normally, the comparision in revenue improvement is based on projected yield increases. There are, however, other benefits of potential importance.

In addition to yield increases, there are often quality increases in harvested crops. Poorly drained lands often have endemic pest problems stemming from parasite insects and weed infestations that are harbored by the wet environment. The wet soils also limit the operations of farm machinery and can cause delays in the timing of critical planting, tillage and harvesting operations. These can add to the pest problems and cause additional quality damage to the crop because of the delays in harvesting.

The costs of tillage, planting and harvesting operations are also normally reduced by improved drainage. Wet spots can delay farm operations and cause equipment scheduling problems that conflict with other demands for the equipment. Wetlands can also cause equipment to get stuck, with resulting damages to the machinery and delays. Wet soils require more power to till the soil, with resulting cost increases for fuel, heavier equipment and additional repairs. Adequate drainage may also avoid replanting costs that result from poor germination caused by the wet environment or from incrustations of the soil surface. These restrictions on operations also affect the timing and choice of pesticides and fertilizers and the application methods. More freedom of these choices could increase quantity as well as quality of the production. Of greatest importance, perhaps, will be the benefits derived once the producer is no longer limited in his selection of cropping alternatives. With these soil restrictions lifted, he would be free to adopt improved crop mixes and rotations and increase net returns.

Isolating the effects of flooding and drainage on the agricultural productivity of flood plains is difficult because of the multiplicity of factors involved. It has been shown that there is only a small difference between damage as the result of flooding and damage from highwater tables or waterlogged soils in general.[9] Quantitative studies showing the effects of flooding and drainage have been prepared by USDA.

Table 23 shows the crop yields computed for adequately drained, poorly drained, and average soils in the United States. Also computed were the acreage equivalent that results from drainage improvements (total potential yield increase from cultivated acreage needing drainage divided by state average yield.) For the 14 major crops examined, drainage improvements could produce an acreage equivalent of over 14 million acres at 1973 average yields.

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[9] Robert M. Hagan, and Bessel D. Van't Woudt, "Crop Responses at Excessively High Soil Moisture Levels," in Drainage of Agricultural Lands, James N. Luthin (ed.), Madison, Wisconsin: American Society of Agronomy, 1957, pp. 532-3.

TABLE 23

AVERAGE YIELDS, POTENTIAL ACREAGE EQUIVALENTS BY CROPS

Crop	Unit	Yield adequately drained	Yield poorly drained	1973 average yield-U.S.	Acreage equivalent 1/
					Acres
Wheat	bu	37.6	23.6	31.7	732,304
Rice	lbs	4,633.3	3,966.7	4,274.0	36,606
Corn-Grain	bu	90.6	54.9	91.2	4,355,198
Corn-Silage	tons	21.1	12.0	12.6	80,192
Grain-Sorghum	lbs	2,998.3	1,933.3	3,287	87,448
Oats	bu	69.9	45.2	47.2	325,823
Barley	bu	47.4	28.6	40.3	5,434
Hay	tons	3.5	1.9	2.17	2,470,518
Soybeans	bu	33.1	20.4	27.7	5,689,438
Peanuts	lbs	3,400.0	2,050.0	2,323	10,551
Cotton	lbs	598.4	361.0	520	472,869
Sugar Cane	tons	36.0	34.0	34.9	1,164
Sugar Beets	tons	15.17	9.92	20.1	17,901
Total All Crops					14,285,446

1/ Acreage Equivalent = Total potential increase in yield from cultivated acreage needing drainage/state average yield

This computation is based on the assumption that the cropping patterns on wet soils, predominantly IIw and IIIw, following drainage is the same as for all harvested acreage in the state where the crop occurs.

SOURCE: An Assessment of the Energy Saving Potential of Soil and Water Conservation, Soil Conservation Service, U.S. Department of Agriculture, April 1975 Table 5, P 11.

The increments in yield that might be expected from improving drainage on lands inadequately drained at present are available from a recent survey by the Soil Conservation Service. Included are the principal crops in each of 30 states for three soil types.

OTHER BENEFIT EVALUATION CONSIDERATIONS

The preceding portions of this section have addressed the means of evaluating project benefits. At least one other major area integral to the project evaluation process appears to hold at least equal, and probably more, potential for improving project benefit evaluations. This area relates to the present criteria for establishing the required level of protection for flood control facilities.

Present criteria for protective facilities appear to have been created to insure justifiably conservative safeguards to protect life and high-valued personal property common to intensely developed areas -- urban areas. Agricultural lands do not necessarily require the same minimum construction criteria.

In rural areas, the minimum design, storm frequency and freeboard criteria could be reduced and still remain within prudent limits. A minimum storm frequency protection of 50 or 100 years may not be necessary for rural lands. Instead, we may want to build for a 10-year storm frequency. This would significantly reduce the initial capital investment in a project without appreciably affecting project benefits Concrete spillways could also be replaced by earth- or grass-lined spillways. These types of structure design modifications could lower costs while still maintaining the generally high-quality safety standards that the Corps requires for its projects. Quality and safety standards should, in fact, continue to be maintained when any new structural measures are introduced.

There will be trade-offs within the economic analysis if changes are made in these policies. Accordingly, a larger benefit-cost ratio will not always result. Certainly, maintenance costs for these facilities will increase with the new standards. Similarly, damage will occur more frequently. These trade-offs would understandably be an integral part of a project economic analysis.

The results of these policy changes are not entirely predictable and a thorough examination of these changes is needed. However, from past and present experience with Corps projects, investigating the applicability of changes in this policy area appears justifiable.

Development and Resources Corporation
A perspective on flood protection of agricultural lands / by Development and Resources Corporation. -- Ft. Belvoir, Va. : U.S. Army Engineer Institute for Water Resources, 1976.
75 p. : ill. (IWR contract report ; no. 76-3)
1. Agriculture. 2. Flood control - Program analysis. 3. Flood protection. I. Title. II. Series: U.S. Institute for Water Resources. IWR Contract report no. 76-3.